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BULLETIN No. 27.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF FORESTRY.
GIFFORD PINCHOT, FORESTER.

PRACTICAL TREE PLANTING

IN

OPERATION.

BY

J. W. TOUMEY,
SUPERINTENDENT OF TREE PLANTING.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1900.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Division of Forestry,
Washington, D. C., March 26, 1900.

Sir: I have the honor to transmit herewith a report entitled "Practical Tree Planting in Operation," prepared by J. W. Toumey, superintendent of tree planting in this Division, and to recommend its publication as Bulletin No. 27 of the Division of Forestry. Credit should be given W. L. Hall, assistant superintendent of tree planting, as the field work upon which the report is based was done chiefly by him.

This report describes the practical working of the cooperation with tree planters begun by this Division in July, 1899, under the provisions of Circular 22, and, in addition, it describes the results of successful planting in the past, both for general and for special purposes. In a word, the report shows by actual examples the method pursued by the Division in assisting tree planters, and its probable results.

Respectfully,

Gifford Pinchot,
Forester.

Hon. James Wilson,
Secretary of Agriculture.

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PRACTICAL TREE-PLANTING IN OPERATION.

INTRODUCTION.

In July, 1899, the Division of Forestry issued Circular No. 22, concisely describing a plan of cooperation by which practical assistance is offered to persons desiring to establish woodlots, shelterbelts, windbreaks, and other plantations of forest trees. Under the provisions of this circular the Division is sending expert tree planters to examine the land owned by persons who request its cooperation, so far as the present resources of the Division will permit.

During the months of October, November, and December, 1899, applicants were visited in Minnesota, North Dakota, Nebraska, Kansas, Oklahoma, and Texas. As a result of the examinations thirty-three working plans were made and are being put into execution. Each of these working plans is based upon the special needs of a particular farm, and is prepared after a careful examination of the farm in question.

TREE-PLANTING AGREEMENT.

The tree-planting agreement which was published in Circular No. 22, and which is still in force with few modifications, is as follows:

WASHINGTON, D. C., ———, ———.

The Department of Agriculture of the United States and ——— of ———, county of ———, State of ———, mutually agree as follows:

1. The Department of Agriculture, in pursuance of investigations in forestry and in order to disseminate a knowledge of improved ways of planting and developing forest plantations, woodlots, shelterbelts, and windbreaks, shall, after personal study on the ground by its agents, prepare a plan for planting and caring for a forest plantation, woodlot, shelterbelt, or windbreak, on ——— acres of land of the said ———, situated and described as follows: ——— town of ———, county of ———, State of ———.

2. The said plan shall be prepared for the purpose of promoting and increasing the present value and usefulness of said land to its owner and to develop and perpetuate a plantation of forest trees upon it.

3. Upon the completion of the said plan and its acceptance by the said ———, the Department of Agriculture shall supervise the execution thereof so far as may be necessary.

4. The Department of Agriculture shall not furnish seeds and trees, nor participate in any degree in the expenses of planting and caring for said forest plantation, woodlot, shelterbelt, or windbreak, nor share in any profit which may arise from its growth.

5. The Department of Agriculture shall render all services under this agreement wholly without charge to the said ———, but if the plantation described in paragraph 1 be of such a nature as to require inspections subsequent to the preliminary examination, and such inspections be made upon the special request of the owner, said owner shall pay the actual and necessary expenses for traveling and subsistence of the agent or agents of the Department working under this agreement. What are "actual and necessary expenses" shall be determined by the printed regulations of the Department.

6. The Department of Agriculture shall have the right to publish and distribute the said plan and its results for the information of farmers and others whom it may concern.

7. This agreement may be dissolved by either party upon ten days' notice given to the other.

(Signed) ——— ———,
Owner.

(Signed) ——— ———,
Secretary of Agriculture.

Post-office: ———, Date: ———

The working plan above mentioned, being completed, is now accepted, and will be carried out under the conditions and during the validity of the above agreement.

(Signed) ——— ———,
Owner.

It is necessary that persons who desire the assistance of the Division, as indicated in this agreement, should make their applications some months in advance of the time when they desire to plant, in order to afford ample opportunity for an agent of the Division to visit the land of each applicant and complete the plans under which the work is to proceed sufficiently early so that the necessary young trees and seeds may be obtained from the most desirable regions and from responsible seed dealers and nurserymen in time for spring planting.

THE COOPERATIVE PLAN.

The method by which the Division carries on the cooperative work in tree planting is as follows:

Every application when received is placed on file, and the applicant notified of its receipt. As soon as it is ascertained at what time an expert tree planter of the Division will be able to reach the land owned by the applicant, he is notified when the agent may be expected, and later, the day and hour when he will arrive. In places where suitable arrangements can be made a public meeting is arranged for, so that all persons in the neighborhood interested in tree planting may attend it and confer with the agent on any matter pertaining to forest tree planting.

The agent, accompanied by the applicant, goes over the ground of each of the proposed plantations, and obtains all available data that will be of assistance to him in making planting plans best suited for each farm visited. On account of the effect of local conditions on tree growth this personal examination is necessary in order to give trustworthy advice regarding the method of planting and the kinds of trees to plant.

The following are some of the local conditions which must be taken into consideration in satisfactorily establishing plantations of forest trees:

(1) In prairie regions trees that succeed on bottom land and bench land frequently fail on upland.

(2) The position of the farm buildings and orchards must be known in order to plant shelter-belts and wind-breaks most advantageously.

(3) The local soil and moisture conditions determine in a large measure the best trees to plant and the best place for the plantation.

(4) The purpose of the plantation must in a degree determine the kinds of trees to plant.

From the data obtained by personal examination and consultation with the applicant, planting plans are made and sent to the owner. These plans include a carefully prepared map of the whole or a part of the farm visited, having the proposed wind-breaks, wood lots, shelter-belts, or other forest plantations platted upon it. The instructions incorporated in the planting plans state specifically the way to plant and the number of each species required to complete the plantation, and when mixed plantations are recommended diagrams show how these mixtures are to be made. Sundry instructions are also included regarding the growing of forest-tree seedlings, care of nursery stock, special care of evergreens, and the preparation of the soil.

At the time the examination is made by the agent the applicant signs the agreement at the first point indicated, thus expressing his desire to have planting plans prepared, under the conditions stated therein. After the planting plans are prepared and the agreement signed by the Secretary of Agriculture, they are transmitted to the owner, and, if accepted by him, he signs the agreement inclosed with the plans, at the second point indicated, and returns it to the Division of Forestry. In instances where it is considered necessary, and when circumstances permit, visits are made to the cooperative plantations after the planting plans have been put into execution, and, in some cases, during the time of planting, but such visits are made at the expense of the Division of Forestry, unless specifically requested by the applicant.

Although this plan of cooperation has been in operation less than a year, the results already obtained in bringing the Division into closer relations with land owners desiring to establish plantations of forest trees, particularly in the treeless regions of the West, are most satisfactory, and the work is rapidly expanding.

THE TREE-PLANTING SECTIONS OF THE UNITED STATES.

Although applications for assistance in establishing plantations of forest trees are being received from nearly every State, more than 90 per cent come from the treeless regions of Texas, Oklahoma, Kansas, Nebraska, and the Dakotas, regions where tree planting is most needed for protection to stock, orchards, and buildings, and for fuel, posts, and other farm purposes.

This center of tree-planting activity, being as it is an open prairie, must depend upon careful and painstaking planting to approach the conditions prevailing in regions originally wooded, where trees grow when once planted without further attention. This fact is most forcibly illustrated in the present condition of many tree claims on the prairies of the West. Although occasional plantations have been successful, as illustrated in Plate I, fig. 1, the greater number, on account of unfavorable locations or lack of proper attention in planting and subsequent care, have been failures. The illustration shown in Plate I, fig. 2, represents the present condition of hundreds of such claims, and is a strong argument in favor of better judgment regarding the selection of locations for plantations and of fuller knowledge of the proper care and management of forest trees in the plantation.

Adjacent to the great plains between the Rocky Mountains and the Mississippi River there is both an eastern and a western limit of tree growth under natural conditions—that is, a place where trees give way to lower forms of vegetation. This limit is largely fixed by the amount and the season of rainfall, although before the period of settlement it was determined to considerable extent by prairie fires. If we plant trees beyond this limit it is evident that they will have to be handled differently from the way nature treats the trees which spring from seeds blown or otherwise carried upon prairie lands from distant woodlands. In the latter case the self-sown seeds frequently germinate, but in the struggle of the young trees for existence among the prairie grasses they invariably die. If they did not there would be no prairies. Therefore, when young trees are planted beyond the limits of natural tree growth they must be given some advantage over the indigenous vegetation or they will die, for the same reason that trees starting from self-sown seeds die. They must be protected.

There is probably not a single inhabited region in the United States where some kinds of trees may not be made to grow when given adequate assistance in the way of cultivation and irrigation. In regions of extremely adverse conditions only the hardiest varieties exist, and then only as stunted, poorly developed specimens, even when the best effort is made to modify the existing conditions. On the other hand, in prairie regions adjacent to natural woodlands many varieties of trees grow almost as well, when once established, as they do in the natural forest. The treeless West presents every intermediate condition between these two extremes, but in every case some adverse conditions, calling for more or less effort on the part of man, must be overcome. If these conditions are overcome, trees will grow; if they are not, they will die.

The chief object of the cooperative tree-planting work of the Division

PLATE I.

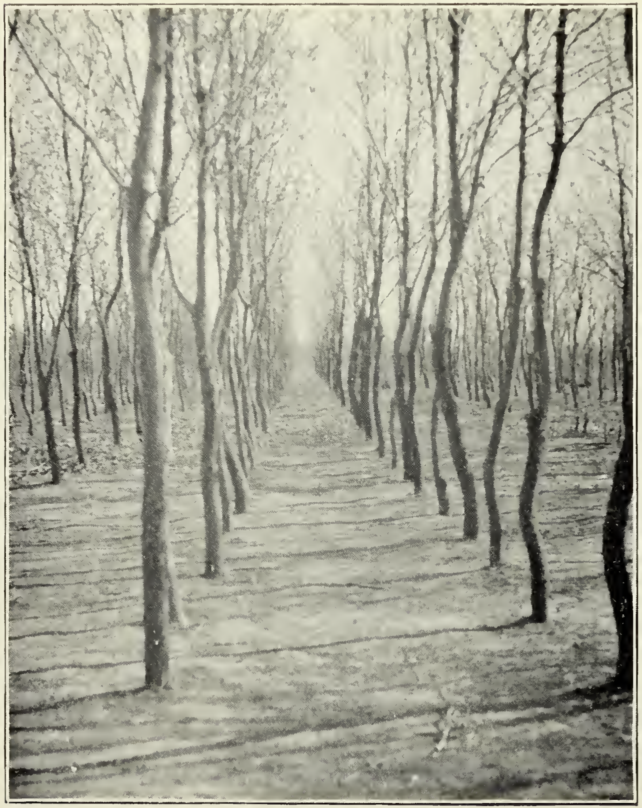

FIG. 1.—A TIMBER CLAIM IN THOMAS COUNTY, KANS., 10 YEARS OLD, AND IN GOOD CONDITION.

The shade is now sufficiently dense to produce a fair forest floor and prevent the growth of prairie grasses.

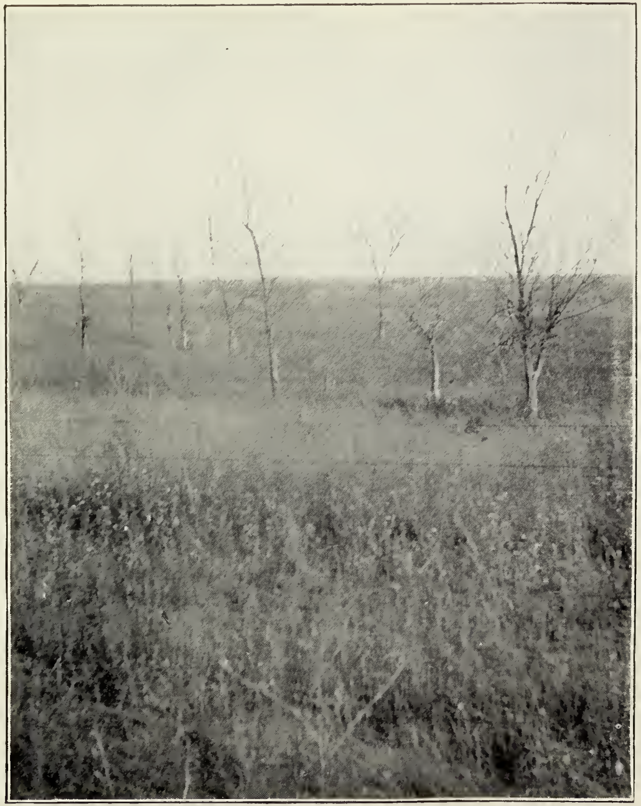

FIG. 2.—A TIMBER CLAIM IN HOLT COUNTY, NEBR., WHERE FOREST CONDITIONS WERE NOT ATTAINED.

The prairie grasses were allowed to occupy the land and the trees gradually died out.

of Forestry is to assist tree planters in overcoming these adverse conditions, and to aid in the establishment of plantations of the greatest possible value to their owners.

FAVORABLE LOCALITIES FOR TREE PLANTING.

Nearly everywhere within the natural wooded areas trees grow with little or no care. Although these localities are especially favorable for tree growth, favorable situations of limited area are not infrequent in what are generally known as treeless localities. In many Western situations where only the hardiest trees succeed at all upon upland and exposed places, benchlands and lowlands along creeks and rivers where the valleys are naturally subirrigated are usually well adapted to tree growth. Such conditions are frequent in the valleys of the Platte, Arkansas, Cimarron, and other rivers of the plains.

In many localities west of the ninety-ninth meridian, and even farther east, much depends upon the selection of the site for the plantation of forest trees upon each individual farm. The question of the location of the farm buildings in relation to future plantations is also of critical importance.

A PLANTATION FOR GENERAL PURPOSES IN SOUTHERN KANSAS.

The following account of the plantation of Joseph Lewis is presented as an evidence of what can be done on the open prairie in a short space of time. This plantation is located in the southern part of Harper County, Kans., in the valley of a small stream called Silver Creek. The soil is a fertile, brown, sandy loam, and reaches some 6 or 8 feet in depth. It is freely permeable, both to water and the roots of trees, containing much water when saturated, and has marked retentive powers. The subsoil is similar to the soil, and a uniform layer of coarse, water-bearing sand is found at a depth of about 15 feet. This kind of soil is producing better trees than any other in the unforested West.

Mr. Lewis settled on this land a little over twenty years ago. He immediately began to improve it, but his main forest plantations were not made until 1882. At this time a 30-acre plat was laid out for an orchard, and on the north, west, and south of this plat a windbreak was planted. On the north of the orchard a strip some 20 rods in width was planted with Cottonwood. On the west a strip about 15 rods wide was planted, at one end with Soft Maple, and at the other with Black Walnut, with the trees about 6 feet apart in one direction and 8 feet in the other. On the south a strip varying in width from 10 to 15 rods was irregularly and thinly planted with Cottonwood, Red Cedar, Soft Maple, Russian Mulberry, and Catalpa. The site of this plantation slopes gradually southward to the creek, which is the boundary of the planting on the south side. On the north side of the plantation the land is from 5 to 10 feet higher than the south side, but of the same kind of soil.

The Cottonwoods made the most rapid growth. Twelve years after planting they were 40 feet or more in height, with trunk diameters breast high of 10 to 12 inches. Two or three years ago nearly all of these trees were cut down. The Cottonwoods on the south side of the plantation, however, were allowed to remain. The house stands among them, and the yard and lots receive ample shade and protection from their broad spreading tops. They are now 50 and 60 feet tall, with tops reaching a maximum diameter of 40 feet.

The Russian Mulberry has made a most vigorous growth. The trees were allowed to branch low, but have reached the height of 30 feet, and have dense tops. Their diameters range from 12 to 14 inches. The branches of these trees would now form ten or twelve good posts to each tree. Soft Maples planted at the same time are now large thrifty trees, 40 feet high and 8 to 10 inches in diameter. They have not yet yielded to the tendency to die out in the top and become stag-headed, so frequently noticed of this species in many places in the West, especially over a clay subsoil. Plate II, fig. 1, represents the present condition of the Soft Maple plantation on this farm, and is in marked contrast to a similar plantation illustrated in Plate II, fig. 2, where desirable forest conditions were not attained.

The Black Walnut is growing near the Maple, so that the difference in size is readily recognized. The diameters are about half as great in the Walnuts as in the Maples. They are now from 4 to 6 inches in diameter, and are from 25 to 35 feet high. With proper care in thinning, the Walnut plantation will stand for many years as a monument to the man who planted and reared it.

One of the most thrifty and profitable orchards in the State of Kansas has been grown in the shelter and protection of this grove. In his report to the Kansas Horticultural Society Mr. Lewis, speaking of his orchard, says, "I believe windbreaks are essential in this country."

The planting on this farm has been of the most practical sort. For the most part desirable trees have been used. They have been planted advantageously both in relation to favorable soil and to the benefits which may be derived from their growth. They were well cared for until they were large enough to protect themselves. The results of this plantation are: First, fuel for household use; second, posts and poles for the building of fences, sheds, and cribs; third, protection to feed lots and buildings from wind and sun; fourth, a profitable commercial orchard in a region where unprotected orchards are a failure; fifth, an increased value of the entire quarter section of land of at least $10 per acre.

What has been done on this farm can not be done upon every farm in the West, because the soil and moisture conditions are more favor-

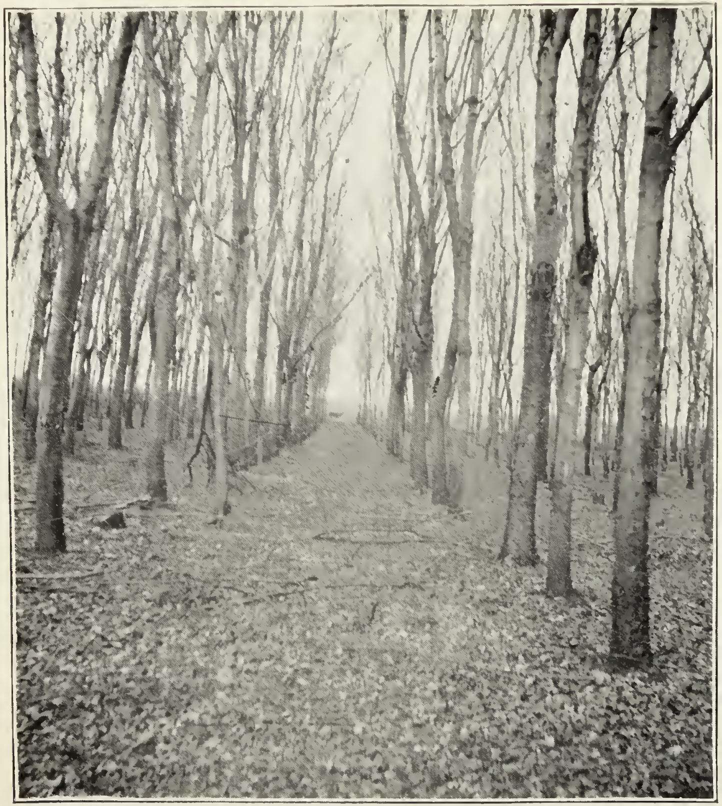

FIG. 1.—SOFT MAPLE FOREST PLANTATION, 17 YEARS OLD, IN HARPER COUNTY, KANS.

Trees 8 to 12 inches in diameter and 35 to 45 feet high. In excellent condition.

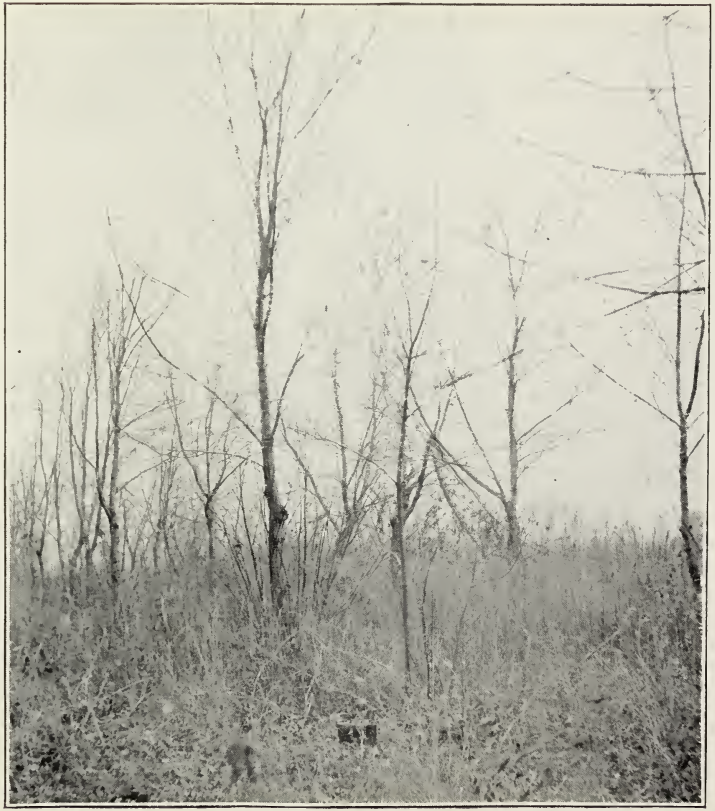

FIG. 2.—SOFT MAPLE FOREST PLANTATION, 12 YEARS OLD, IN PALO ALTO COUNTY, IOWA.

Trees too far apart to keep out the grass. In poor condition.

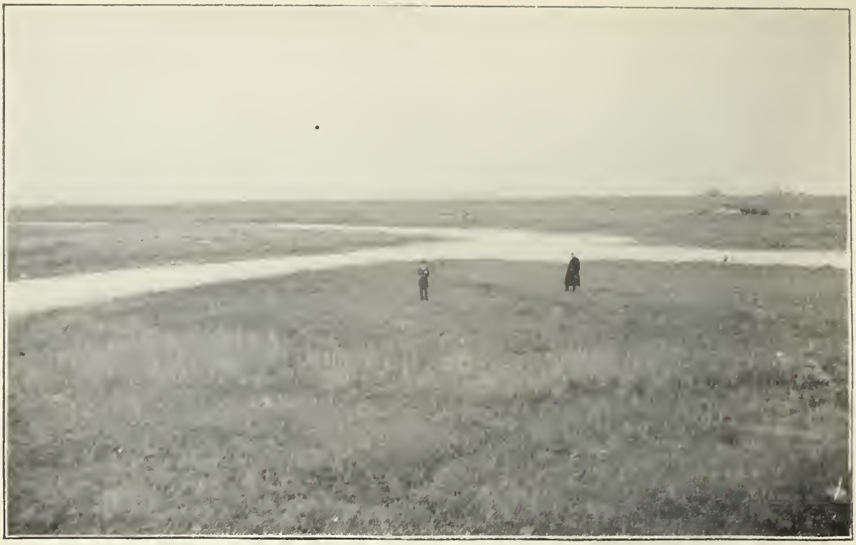

FIG. 1.—SITE FOR FOREST PLANTATION, ACCORDING TO PLANTING PLAN NO. 5, IN EDDY COUNTY, N. DAK.

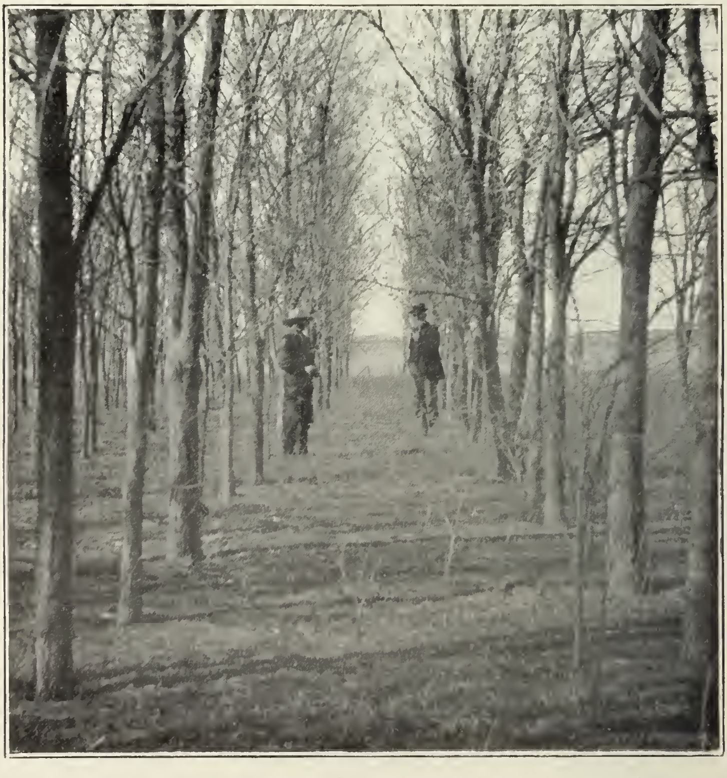

FIG. 2.—BLACK LOCUST FOREST PLANTATION, 12 YEARS OLD, IN MEADE COUNTY, KANS.

Trees 6 to 8 inches in diameter and 30 feet high.

able here than in many places; but there are, nevertheless, millions of acres upon which this successful tree growth can be duplicated.

Successful as this plantation has been, it lacks the element of permanence. Already part of the Cottonwood grove has been cut away, and the land is again prairie. Not an acre of Western prairie land that has been transformed into forest should ever be allowed to revert. The Cottonwood and Boxelder should yield only to the Locust, Ash, Walnut, and Oak, for valuable timber should be the ultimate aim of every Western planter.

Plate III, fig. 1, illustrates what may be expected on the plains of the West in a pure plantation of Black Locust, on soil best adapted to its growth, when properly planted and cared for. In contrast with this desirable plantation, which may be attained with this or other species in many Western regions, there is presented in Plate III, fig. 2, an illustration of the site for a proposed plantation in North Dakota on the open, wind-swept prairie.

PLANTING PLAN FOR A PLANTATION FOR GENERAL PURPOSES ON THE FARM OF MR. P. G. JACOBSON, MADISON, MINN.

This farm is located one-half mile north of Madison, the county seat of Lac qui Parle County, Minn., on the east ½ of section 17, township 118, range 44, west of the fifth principal meridian.

The region in which the farm is located consists of high rolling prairie, with neither natural forest nor natural elevations to break the force of the wind which sweeps over the country at all seasons of the year. The farm consists of 320 acres, at an elevation of about 1,200 feet above the sea level. The surface has no uniform slope, but, owing to a number of knolls with low and irregular depressions between them, slopes in all directions are to be found. These are gradual and slight, with the difference in elevation between the knolls and depressions of not more than 8 to 10 feet. No creeks, ravines, or water runways occur upon the farm.

The soil, like that of the entire region, is a deep, black, heavy marl of glacial origin, with enough clay to make it adhesive when wet, and somewhat difficult to cultivate. It contains a large admixture of vegetable mold, which renders it more porous and friable than it would otherwise be. Its absorptive capacity is large and its retentive powers so great that it resists drought very well.

At a depth of from 3 to 4 feet a light, yellow clay subsoil appears and continues down to the water level, some 20 to 25 feet below the surface. It is sufficiently porous to allow the percolation of water through it, and at times becomes so saturated that the water drains out into cellars.

The several farm buildings are located near the south side of the farm, adjacent to the public road, which follows the section line. In front of the house, near the road, is a low, swamp-like spot one-half acre in extent, which will be drained. A residence is to be erected in the future somewhat in front of and a little to the east of the present house.

The plantation for general purposes proposed for this farm is as follows: Beginning on the south line of the farm, a wind-break 15 rods wide, will extend northward 60 rods; at the north end of this and forming an L with it, a belt 6 rods wide, extends 30 rods to the east.

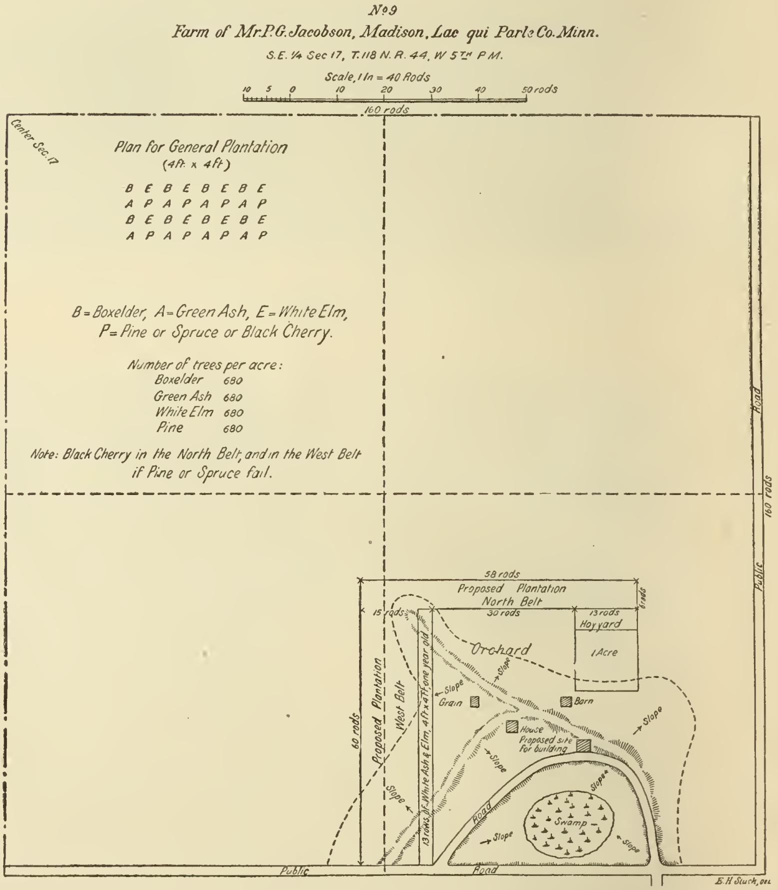
No 9
Farm of Mr. P. G. Jacobson, Madison, Lac qui Parle Co. Minn.
S.E. 1/4 Sec 17, T. 118 N. R. 44, W 5TH P.M.
Scale, 1 In = 40 Rods
10 5 0 10 20 30 40 50 rods
160 rods
Center Sec. 17
Plan for General Plantation
(4ft. x 4ft.)
B E B E B E B E
A P A P A P A P
B E B E B E B E
A P A P A P A P
B = Boxelder, A = Green Ash, E = White Elm,
P = Pine or Spruce or Black Cherry.
Number of trees per acre:
Boxelder 680
Green Ash 680
White Elm 680
Pine 680
Note: Black Cherry in the North Belt, and in the West Belt if Pine or Spruce fail.
58 rods
Proposed Plantation
North Belt
30 rods
13 rods
Hog yard
1 Acre
6 rods
15 rods
Orchard
Slope
Grain
Barn
House
Proposed site for building
60 rods
Proposed Plantation
West Belt
13 rows of White Ash & Elm, 4ft x 4ft, one year old
Swamp
Road
Public
Public Road
160 rods
E. H. Stuck, del.

FIG. 1. Planting plan No. 9, for a plantation for general purposes on the farm of Mr. P. G. Jacobson, Madison, Minn.

This plantation will protect the buildings and lots on the west and north and also an orchard which will be planted on the slope north of the house. The present plantation will cover 8 acres. Later it will be extended west and north until 15 acres are covered. The north part of the plantation is on a northern slope, the south part on a southern slope. The land has already been plowed in preparation for spring planting.

The purposes of the plantation are general: First, to serve as a wind-break, shielding the house, barn, and orchard from the southwest, west, northwest, and north winds; second, to provide a supply of fuel, posts, and poles for farm use; third, to increase the value and attractiveness of the farm. With these objects in view it is desired to plant such trees as will thrive and produce a grove of timber of good appearance and quality. It is so planned that if properly managed it should grow more valuable with age and endure as a permanent plantation.

The only planting already done upon the farm consists of 1,000 each of White Ash and Elm, set last year 4 by 4 feet apart on the site of the west belt. Nearly all the trees grew. The owner desires to make this a part of the permanent plantation.

In neighboring plantations White Elm, White Ash, Boxelder, White Willow, Cottonwood, Russian Poplar, and Balm of Gilead have been grown with success. Soft Maple thrives, but is badly broken by the wind in winter when covered by ice and snow. White Pine, Austrian Pine, Scotch Pine, and White Spruce in limited quantities have been tried, but have suffered from winterkilling. As the summer growth is very rapid and does not usually mature fully, the trees are easily killed by the ensuing cold of the winter. It is the general opinion that conifers will not be successful in this community, but the conclusion is based on too limited experience. The following plan will be followed in the execution of this planting:

Plan for general plantation.

(4 feet by 4 feet.)

B	E	B	E	B	E	B	E
A	P	A	P	A	P	A	P
B	E	B	E	B	E	B	E
A	P	A	P	A	P	A	P
B	E	B	E	B	E	B	E
A	P	A	P	A	P	A	P
B	E	B	E	B	E	B	E
A	P	A	P	A	P	A	P

B=Boxelder. A=Green Ash. E=White Elm. P=Pine, Spruce, and Black Cherry.

Number of trees per acre.

Boxelder	680
Green Ash	680
White Elm	680
Pine, Spruce, and Black Cherry	680

NOTE.—Black cherry should be planted in the north belt as alternate trees in the even rows; this will take about 1,500 trees. The 3,850 coniferous trees should occupy similar positions in the west belt.

EXPLANATION OF PLAN.

The planting is to be made in two belts, one on the north of the buildings, 6 by 30 rods, and one on the west of the buildings, 15 by 60 rods.

The plan calls for Boxelder, Green Ash, White Elm, Black Cherry, and conifers. In the first row Boxelder and Green Ash are to alternate, in the second row White Elm and a conifer alternate in the west belt, while in the north belt Black Cherry comes in the place of the conifer. The conifers, which consist of 1,100 White Pine, 1,250 Red Pine, and 1,500 Douglas Spruce (Red Fir), are not to be set in the permanent plantation during the spring of 1900, but are to be set 1 foot apart in nursery rows. If their growth be rapid, cultivation should cease by midsummer. Next winter they may be slightly protected by straw placed about them. In the spring of 1901 they are to be set in the permanent plantation. It is recommended that 1-year old seedling deciduous trees be used in the planting, on account of their cheapness and the ease and safety of transplanting.

To insure hardiness in the stock the trees are to be obtained from nurseries with climate corresponding to that into which they are to be be transplanted.

The method of mixing the trees is definitely shown by the accompanying planting plan.

In case the Black Cherry can not be obtained for planting this spring its planting may be delayed till the spring of 1901. An order for the stock should at once be placed with a nurseryman, so that he may be able to have it when needed.

CARE OF NURSERY STOCK.

When forest-tree seedlings are received from the nursery, they should be immediately unpacked, the roots puddled, and the plants heeled in to await favorable weather for planting. Yearling stock, which is the best age for such quick-growing varieties as Cottonwood, Boxelder, Soft Maple, Russian Mulberry, Catalpa, White Elm, Black Cherry, Black Walnut, Black Locust, and Honey Locust, will seldom require special treatment. If they have made unusual root growth it may be necessary to prune the roots in order to make the planting easier, but this should be sparingly done. It is quickly accomplished by chopping the tips with a sharp ax before the bundles are untied, leaving the roots at least 8 inches long.

Before the plants are unpacked a puddle should be made by digging a hole convenient to the place of heeling in, and mixing in it equal parts of loam and fresh cow dung with enough water to reduce the whole to a mixture sufficiently thick to adhere to the roots readily. As each bundle is taken out it is untied, the roots spread, and dipped in the puddle to the collar, so that every root is covered. A trench having been previously opened a spade deep, with one side an inclined plane, the puddled trees are spread upon the slant in a thin layer, care being taken to have the collars as nearly uniform as may be, and the trees are then covered with a thin layer of fine soil, which should reach an inch or two above the collars. This is firmly tramped, and well smoothed, and then a second layer of trees is "heeled in." The soil adheres to the muck on the roots, and thus prepared they can be handled with much less danger of drying than if heeled in without puddling.

Each species should be heeled in by itself, one layer against another, with a narrow alley between it and the next species. If the trees are to remain heeled in for some little time a shady location should be selected, or the trees should be shaded with a light mulch of straw or prairie hay.

The trees should be left thus heeled in until favorable weather for planting comes. It is the variable weather of early spring which is so often responsible for failure in tree planting, and in the West particularly every precaution should be taken to use the most favorable time for planting. To this end stock should always be ordered to be delivered at the earliest possible date after danger of freezing in shipment is passed. If received when the ground is frozen it may be kept safely in a cool cellar, to be heeled in when the frost is out of the ground. If the spring rains are delayed, the stock should not be disturbed. This is why it is important to heel in trees on the north side of a barn, or other place where the shade will retard their sprouting.

If the soil is in good condition as to moisture, cloudy weather is the most favorable for planting, not only because there is less danger of drying the roots of the trees, but also because there is less evaporation. A few days of cloudy weather will enable the trees to establish themselves almost without check.

Conifers, with the exception of Larch, should be left to the last in planting, as they start later than broadleaf trees. It frequently happens that large loss of Pines, Cedars, and Spruces is caused by early planting, followed by a period of bright sunshine and dry weather. Had the conifers been left in the shade well-heeled in they would have been protected from the bright sun, and in good condition for planting when the rains came.

Many successful planters never set evergreens until the root tips show signs of growth. If when the root tips begin to swell and whiten the soil moisture is favorable and cloudy weather prevails, the best possible combination of circumstances for transplanting has been secured.

TRANSPLANTING EVERGREENS.

Evergreens require more careful attention in transplanting than deciduous trees. The latter may dry out and become shriveled, yet with proper attention be revived and live, but the former, once dried in the least, never regain their vitality. This accounts for many failures in transplanting evergreens. The rules laid down for the handling of deciduous trees when received from the nursery need not be changed for conifers, but they must be followed with very much more care and exactness. It is necessary that no delay shall occur during shipment and that the stock should be taken care of immediately upon reaching its destination. The planter must not let anything whatever interfere with the immediate unpacking, puddling, and heeling in of the stock. Heel in the trees in a cool place protected from sun and wind, and await a favorable day for planting. The stock should be on hand by the time the ground ceases to freeze, and should be planted in the first good planting weather thereafter. It is unwise to delay, for another favorable time may not come. Good planting weather should be construed to mean a time when the soil is well supplied with moisture, and a day when the sun is obscured by clouds and the atmosphere moist and still. Setting the trees is the final act in a very important series of movements. Perform it as though everything in the success of the trees were dependent upon it. See that the roots are kept moist all the time, that the holes are ample for them, and that good soil is firmly packed about them. Usually the best success is attained by planting evergreens very close together, growing them, particularly in prairie regions, under partial shade for one year after they are received from the nursery, and placing them in the permanent location the following spring. It is sometimes necessary to clip the side branches of evergreens that the tops may be reduced in proportion to the roots. Never allow the leader to be injured in any way.

PREPARATION OF THE GROUND.

Trees succeed best upon land which has been thoroughly subdued from the wild condition. Four or five years of cultivation should usually precede the planting of trees on most prairie soils. After the first breaking of the sod, which is properly very shallow, the plowings should be successively deepened until 7 or 8 inches of the surface soil have been mellowed by cultivation and weathering. The growing of farm crops, especially deep rooting crops such as corn, helps much to prepare the ground for the reception of trees. In the fall previous to planting, the land should be plowed deeply and left rough over winter. In the spring it should be worked into a mellow condition and marked for planting. An implement such as a corn marker may be used, but in many portions of the West a furrow made with a plow or lister is to be recommended. The rows should be carefully spaced by measurement rather than by guess. If the rows are correctly spaced and staked it is usually a very easy matter to run them very nearly straight. If the soil tends to dry out rapidly the furrows should not be made far ahead of the planting.

In almost all cases it is necessary to space the trees by measurement in the rows. This may be easily done by means of a check row line, marked so as to show where the trees are to stand. If care be taken to establish the line correctly in each row and to plant by the mark, the cross alignment will be very accurate.

The trees should be set a little deeper than they grew in the nursery and should have the fine surface soil made firm about the roots. They should have thorough surface cultivation, especially during the early part of the season. In most sections of the West cultivation should continue all summer, but in the North, where the seedlings are likely to winterkill if the wood is not well matured, cultivation should cease in late summer.

Cultivation carried on in this way should be the unfailing rule in almost all Western planting. It must be continued until the shade ot the trees becomes so dense that weeds will not grow and the leaves, gathering on the ground, form a mulch between the trees sufficient to retain the moisture in the soil.

On account of more rapid growth in plantations made along streams, frequent cultivation can not, in all instances, be followed. In such cases the natural moisture of the soil and the adaptability of the location to tree growth may be sufficient to equalize the loss which the tree sustains from lack of tilth.

A PLANTATION FOR SPECIAL PURPOSES IN CENTRAL KANSAS.

The Catalpa plantation of Mr. L. W. Yaggy, located 4 miles west of Hutchinson, Kans., in the sandy valley of the Arkansas River, is a most interesting example of the growing of forest trees as a financial investment. The plantation consists of 440 acres planted entirely to Hardy Catalpa at the uniform distance of 3½ by 6 feet apart. The first planting, consisting of 120 acres, was done in 1890; 80 acres were planted in 1891, and 240 acres in 1892. On account of the expense and difficulty of obtaining trees from commercial nurseries for the planting of so large a tract, Mr. Yaggy grew his own stock, thereby greatly reducing its cost. The trees were set in the permanent plantation when 1 year old. They were planted in furrows laid off 6 feet apart. A line was stretched in the furrows, marked at spaces of 3½ feet, and stationed each time so that the rows should begin evenly. The trees were set at the points marked on the line, and a fair alignment was secured in all directions.

Almost a perfect stand was obtained, and, except in a very few spots of hardpan, the trees made a rapid growth from the first. The soil upon which the plantation is located is a sandy loam several feet in thickness, underlaid by a soft clay subsoil, which also contains a large admixture of sand. Both soil and subsoil are permeable to water and are well adapted to tree growth. The water table is about 8 or 10 feet below the surface. The subsoil and soil are thus subirrigated, so that the trees do not suffer from lack of moisture.

When the trees were 2 years old they had formed tops by branching at 3 to 5 feet from the ground. As the object of the owner was to secure straight, clear boles, the branching was considered a defect. The trees were therefore cut back to the ground, leaving, however, several strips of 3 rows each at uniform distances apart, extending east and west through the plantation as windbreaks for the tender growth of the next season. The stump of each tree so cut back threw out several sprouts which reached a height of from 6 to 12 feet the following season. The next winter most of the sprouts were cut away, leaving only the most vigorous one at each stump to form the tree. During the following year the upward growth continued, side branches appearing at heights varying from 8 to 12 feet. According to Mr. Yaggy's statement, given below, cultivation ceased after the third year. After this the shade of the trees became so dense that weeds and grass did not grow. The accumulation of leaves soon formed a mulch, so that the transition from a cultivated field to a dense young forest with excellent conditions of forest floor and cover was complete.

Thinning began in the older parts of the plantation in the winter of 1897–'98. After six seasons' growth from the time of cutting back, 2,500 trees were cut from an 80-acre tract, and the next year 13,000 trees were removed from the same tract. In each cutting only the largest trees were taken. Each tree removed made 2 posts, the larger with a butt diameter of from 4 to 6 inches, and the smaller of from 2½ to 3½ inches. The posts were sold at the plantation, the lower cuts bringing 10 cents each and the upper ones from 4 to 6 cents each. About one-eighth of the trees were removed in these two cuttings. An illustration of the present appearance of this plantation is shown in Plate IV, fig. 1.

Through the courtesy of Mr. Yaggy, valuation measurements of two typical areas of one-half acre each, one on the exterior and one on the interior of the plantation, were made in January, 1900, under the direction of the Division of Forestry. The measurements were made by the foreman of the farm, working under the following instructions:

Mark off one-half acre on the north edge of the older plantation, representing an average of the outer area of the plantation. This area should extend 10 rods south, including 27 rows of trees, and 8 rods west. The trees on this area are to be counted and their diameters measured with calipers, at heights of 1 and 7 feet. When measuring the trees a record is to be made of the number of posts and stakes each would furnish at the present time, and the value of each reckoned on previous sales from the plantation. A record is also to be made of the value of the wood contained in the parts of the tree unfit for posts and stakes. The measurements and records for each tree are to be tabulated upon sheets forwarded from the Division of Forestry. These sheets are ruled into columns headed to show the number of the tree, the diameter 1 foot above ground, the diameter 7 feet above ground, number of posts the tree will make, value of posts, number of stakes, value of stakes, value of wood, and total value of tree. As few stumps as possible are to be included in the areas mentioned, but where trees have been cut the diameters of the stumps are to be taken and an estimate made of the value of the posts and stakes obtained from them.

The same measurements are to be taken on a half acre similarly laid off, represent-

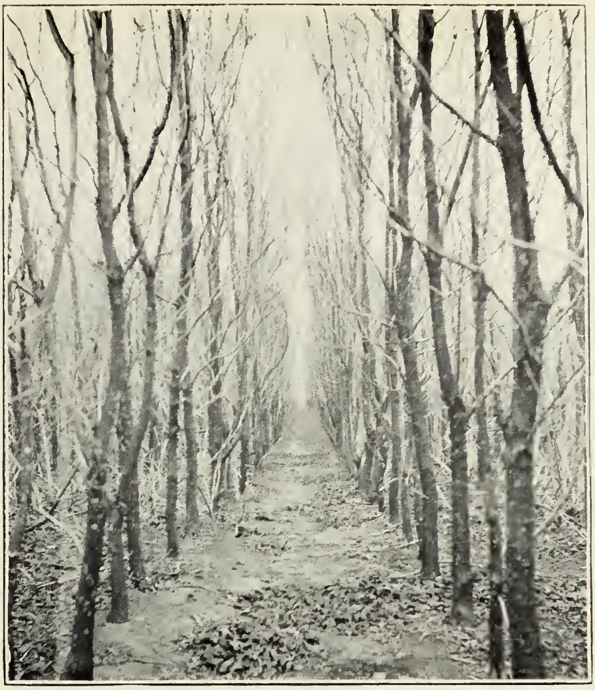

FIG. 1.—THE YAGGY CATALPA PLANTATION, IN RENO COUNTY, KANS.

Rows 7 to 12 feet apart; age 10 years. Trees 4 to 6 inches in diameter and 25 to 28 feet high.

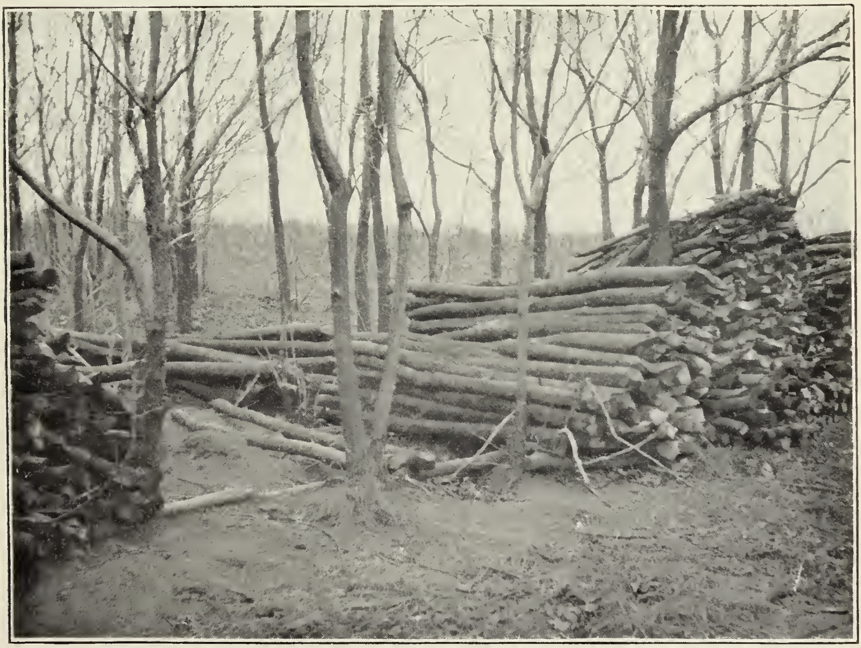

FIG. 2.—THE YAGGY CATALPA PLANTATION, IN RENO COUNTY, KANS., SHOWING POSTS CUT WHEN TREES WERE 9 YEARS OLD.

The posts are from 4 to 6 inches in diameter, and many of the trees made two posts.

ing the interior conditions of the grove, and located far enough within the plantation to be entirely uninfluenced by the open ground.

The results of the measurements are shown in the following table:

Locality.	Area.	Number of trees.	Number of posts.	Value.	Number of stakes.	Value.	Value of wood.	Total value of trees.
	Acre.							
Edge of plantation	½	944	811	$81.10	1,888	$47.87	$28.92	$157.89
Interior of plantation	½	891	496	49.62	1,341	36.15	23.49	109.26
Total on average acre	1	1,835	1,307	130.72	3,229	84.02	52.41	267.15

From these figures it appears that the gross value of the timber crop produced in ten years is $267.15 per acre.

In reckoning the cost of the plantation per acre, Mr. Yaggy's own figures have been used. They are as follows:

> I bought the best river-bottom land, with rich, moist, loamy soil, for which I paid $25 per acre. It was cultivated in corn two years before I planted trees upon it. The cost of raising sufficient trees to plant an acre was $3.60; cost of planting with listers and plows, $3.20 per acre. The rows being 6 feet apart, rows of corn were planted between the rows of trees. In cultivating the corn the trees received nearly as much cultivation as was necessary. About three cultivations were sufficient the first year, cost $1.20. The second year the trees needed no cultivation. The third year three cultivations were sufficient. After that time no more care was required.
>
> It costs about $2.50 per acre to cut back the trees and sprouts. If the cutting off is done early, the cost is small; if it is done when the trees are 3 or 4 years old, the wood pays for the cutting. One sprouting in July (the year following cutting back) is sufficient.

The foreman of the farm states that it costs 1¼ cents each to cut and deliver posts at the station; from which statement we estimate that the cost of marketing the present crop is $20 per acre.

Counting the rent of this land at $2 per acre, the expenses of growing the crop and marketing the product at the present time are therefore to be summarized for 1 acre as follows:

Rent of land 10 years, at $2	$20.00
Cost of raising plants from seed	3.60
Cost of planting	3.20
Cost of cultivation, first year	1.20
Cutting back and sprouting	2.50
Cost of cultivation, third year	1.20
Cost of marketing crop	20.00
Total	51.70

Deducting $51.70, the total cost of growing and marketing the timber grown on 1 acre, from $267.15, which is the gross value of the product in hand, there remains a net value of $215.45 per acre, or, including the interest on the investment, an annual profit of $21.54. Allowing 6 per cent compound interest on the expenditures from the time incurred until the expiration of the ten years, the total expense per acre was as follows:

Year.	Amount expended.	Amount 6 per cent compound interest.
First	$10.00	$17.91
Second	4.50	7.60
Third	3.20	5.10
Fourth	2.00	3.00
Fifth	2.00	2.84
Sixth	2.00	2.68
Seventh	2.00	2.52
Eighth	2.00	2.38
Ninth	2.00	2.25
Tenth	22.00	23.32
Total	51.70	69.60

Deducting $69.60 from $267.17, the gross value, we have a net profit of $197.55 per acre.

These results show the value of an acre at the present time when the trees are but 10 years old. It would be very unwise to remove all the trees at this time. If only a portion of the trees are marketed each year for the next 10 years, and the trees cut out are distributed so as to give more sunlight to those that remain, the net profit per acre will be very much increased.

Plate IV, fig. 2, is an illustration from the edge of the plantation where the posts have been drawn out and are made ready for market.

The results obtained by Mr. Yaggy can not be duplicated by every farmer in the Catalpa belt. The loose, sandy soil of this plantation, with water table from 8 to 10 feet below the surface, is particularly adapted to the growth of the Catalpa.

A notable instance of a Catalpa plantation unwisely located is found near Kiowa, in Barber County, Kans. This plantation for the most part is on dry upland. The soil is composed of red loam underlaid with sandstone at a depth of 8 to 12 feet. In 1883, 250,000 nursery grown trees were set in the plantation. A large proportion of the trees used were Hardy Catalpa, but some Black Locust, Black Walnut, Russian Mulberry, and Black Cherry were also planted in mixture with the Catalpa. Large areas of this plantation have entirely died out, although the cultivation for several years was the very best.

It is noticeable that the trees on the higher lands have suffered most, and those that survive are only a third or a half the size of those in the ravines. Although these trees were set seventeen years ago, the largest of the Catalpas will make but one good post, while those that remain in the drier portions of the plantation have branched near the ground and are of no value except for fuel. The location is unsuited for the growth of the Catalpa. The Locust, Mulberry, and Elm do much better, but even these can not be called wholly successful.

PLANTING PLAN FOR A PLANTATION FOR SPECIAL PURPOSES ON THE FARM OF MR. JESSE H. DUNN, ALVA, OKLA.

The farm is located one-half mile east of the town of Alva, the county seat of Woods County, Okla., on the S. ½ NE. ¼ of sec. 24, T. 27, north of base line, range 14, west of Indian meridian.

This farm, consisting of 80 acres, adjoins the town site of Alva on the east. It is near the south side of the Salt Fork of the Arkansas River, and comprises about 50 acres in the low bottom of the river, and 30 acres on the second bottom lying 20 to 25 feet higher. The embankment separating the first bottom from the second is an almost perpendicular bluff of red marl about one-half mile from the river. The first bottom is low and for the most part is level land from 4 to 8 feet above

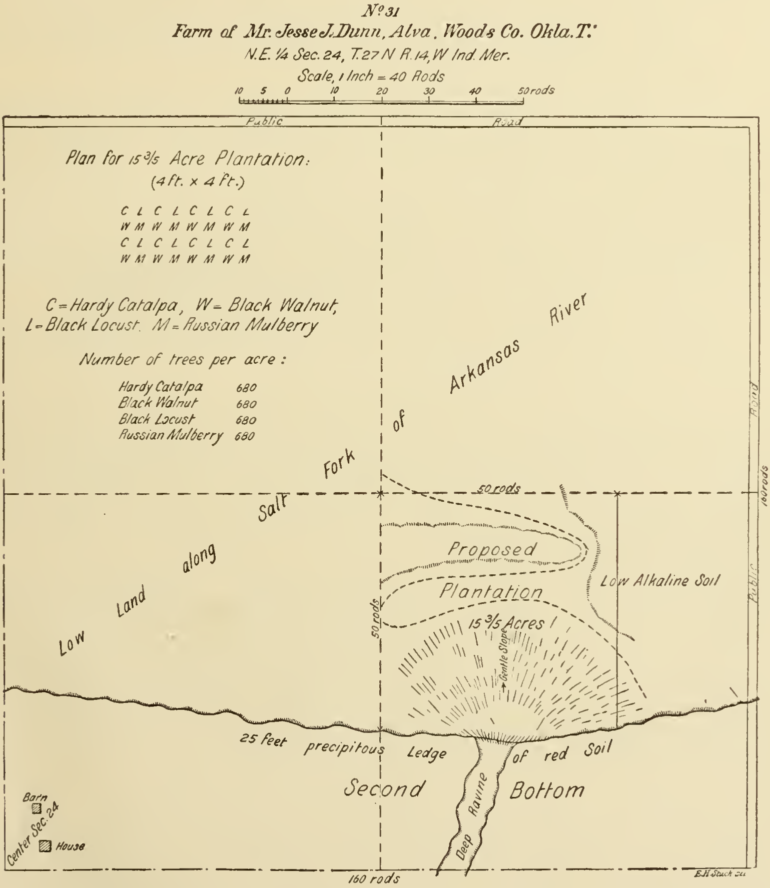
No. 31
Farm of Mr. Jesse J. Dunn, Alva. Woods Co. Okla. T.
N.E. ¼ Sec. 24, T. 27 N R. 14, W Ind. Mer.
Scale, 1 Inch = 40 Rods
10 5 0 10 20 30 40 50 rods
Public Road
Plan for 15⅗ Acre Plantation:
(4 ft. x 4 ft.)
C L C L C L C L
W M W M W M W M
C L C L C L C L
W M W M W M W M
C=Hardy Catalpa, W= Black Walnut,
L=Black Locust. M=Russian Mulberry
Number of trees per acre:
Hardy Catalpa 680
Black Walnut 680
Black Locust 680
Russian Mulberry 680
Salt Fork of Arkansas River
Low Land along
50 rods
160 rods
Proposed Plantation 15⅗ Acres
Gentle Slope
Low Alkaline Soil
Public Road
50 rods
25 feet precipitous Ledge of red Soil
Second Bottom
Deep Ravine
Barn
House
Center Sec. 24
160 rods
E.H. Stuck

FIG. 2. Planting plan No. 31, for a plantation for special purposes on the farm of Mr. Jesse J. Dunn, Alva, Okla.

the level of the river. In composition the soil varies from loamy sand to clay, being a mixture of the sand of the river and the red clay of the uplands. Water-bearing sand occurs at a depth of from 2 to 6 feet below the surface. In some of the lower places alkali appears in such quantity as to interfere with the growth of the blue-stem grass that for the most part covers the bottom. On account of the nearness of the underground water to the surface, and the fact that the river sometimes overflows the lower portion, the land is frequently wet.

A wide difference exists between the conditions in the first and second bottoms. The latter, depending entirely upon rainfall, has a very dry though fertile soil. In composition it is a deep, heavy, red marl. A large ravine or canyon opens into the river valley at the point where the plantation is to be made.

The red soil and the subsoil of the first bottom is readily penetrated by water, and when saturated holds much moisture. Owing to the very finely divided condition of the soil particles, the capillary movement of moisture through the soil is quite rapid, so that the retentive power is not naturally great. In the low valley this strong capillarity is advantageous, because it tends to keep the surface soil constantly supplied with moisture from the undiminishable supply below.

The proposed plantation is a tract 50 rods square, lying wholly in the first bottom, near the east side of the farm. It is bounded on the south by a high bluff, and contains the mouth of the ravine mentioned above, with its alluvial deposit. The land was first broken four or five years ago, but the sod has never been killed and each spring renews its growth. If the land remains uncultivated for a season the sod becomes almost completely reset. Considerable growth of Willow and False Indigo occurs in places.

There is but little natural tree growth in the river valley and none on the upland. Cottonwoods 50 to 60 feet high grow on sand bars in the valley, where fire cannot reach them, and others have grown in protected places under the bluff. It is probable that frequent fires account for the present nonforested condition of the river bottom. In the canyons extending back from the river, White Elm, Honey Locust, Hackberry, and Soapberry occur as scattering trees. Formerly Red Cedar occurred in places, but this has nearly all been cut down. Owing to the fact that this region has been settled but six years, no plantations of more than five years' growth are to be found. Those which have been made are mostly small and consist of Cottonwood. The growth of the trees in these groves has been very rapid, averaging 3 or 4 feet per year. All of these plantations have been made upon the upland, and they have not yet reached the age when the Cottonwood begins to fail in such locations.

The special purpose of this plantation is the production of timber suitable for posts. It must contain a mixture of species which will give durability to the plantation. The following plan of planting is proposed in the execution of the planting plan:

Plan for special plantation.
(4 feet by 4 feet.)

C	L	C	L	C	L	C	L
W	M	W	M	W	M	W	M
C	L	C	L	C	L	C	L
W	M	W	M	W	M	W	M
C	L	C	L	C	L	C	L
W	M	W	M	W	M	W	M
C	L	C	L	C	L	C	L
W	M	W	M	W	M	W	M

C=Hardy Catalpa. W=Black Walnut. L=Black Locust. M=Russian Mulberry.

Number of trees per acre.

Hardy Catalpa	680
Black Walnut	680
Black Locust	680
Russian Mulberry	680

EXPLANATION OF PLAN

The plan proposes Hardy Catalpa, Black Locust, Black Walnut, and Russian Mulberry in equal proportions, planted 4 feet apart each way. In the first row the Catalpa and Walnut alternate, in the second row the Locust and Mulberry alternate, and this order continues throughout the plantation. As the object of the plantation is, first, the production of durable material for posts and poles, and, second, a forest of valuable trees, it is designed that the larger proportion of the Mulberry and Catalpa be removed as soon as they are large enough to be utilized. When the trees begin to crowd again the Locust is to be removed, ultimately leaving the Walnut as the permanent forest growth, with a sufficient number of Mulberry and Catalpa to insure the requisite cover.

If impracticable to plant the entire plat in the spring of 1900, the planting may be extended over two or more seasons, until the whole tract is planted.

BULLETIN No. 28.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF FORESTRY.
GIFFORD PINCHOT, Forester.

A SHORT ACCOUNT
OF
THE BIG TREES OF CALIFORNIA.

Prepared in the Division of Forestry.

1862 1889

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1900.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Division of Forestry,
Washington, D. C., July 28, 1900.

Sir: I have the honor to transmit herewith a report entitled "A Short Account of the Big Trees of California," and to recommend that it be issued as Bulletin No. 28 of this Division.

This report was prepared in accordance with your reference of Senator Hansbrough's letter of April 25, 1900, and has been transmitted to Congress and printed as Senate Document 393, Fifty-sixth Congress, first session.

The original purpose of this report was to furnish information to the Senate Committee on Public Lands, then considering the preservation of the Calaveras and Stanislaus Big Tree groves. Since there is extant no other succinct account of these mammoth trees, it is deemed advisable to issue this publication as one of the regular series of bulletins of the Division of Forestry. A more detailed account of the Big Trees is in preparation by Prof. W. R. Dudley, of Stanford University, a collaborator of this Division, to whom is due the valuable information in this bulletin upon the location and ownership of Big Trees in Fresno and Tulare counties.

Respectfully,

Gifford Pinchot,
Forester.

Hon. James Wilson,
Secretary.

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SUMMARY OF FACTS ABOUT THE BIG TREE.

1. The dimensions of the Big Tree are unequaled.
2. The age of the Big Tree makes it the oldest living thing.
3. The majestic beauty of the Big Tree is unique and world-renowned.
4. It now exists only in ten isolated groves on the west slope of the Sierra Nevada Mountains, and nowhere else in the world.
5. The Mariposa Grove is to-day the only one of consequence which is completely protected.
6. Most of the scattered groves of Big Trees are privately owned, and therefore in danger of destruction.
7. Lumbering is rapidly sweeping them off; 40 mills and logging companies are now at work wholly or in part upon Big Tree timber.
8. The southern groves show some reproduction, through which there is hope of perpetuating these groves; in the northern groves the species hardly holds its own.
9. The Big Tree and the smaller Coast Redwood represent a surviving prehistoric genus of trees (the *Sequoias*) once widely distributed over the globe.

A SHORT ACCOUNT

OF

THE BIG TREES OF CALIFORNIA.

INTRODUCTION.

Before the glacial period the genus of big trees called Sequoia flourished widely in the temperate zones of three continents. There were many species, and Europe, Asia, and America had each its share. But when the ice fields moved down out of the north the luxuriant vegetation of the age declined, and with it these multitudes of trees. One after another the different kinds gave way, their remains became buried, and when the ice receded just two species, the Big Tree and Redwood, survived. Both grew in California, each separate from the other, and each occupying, in comparison with its former territory, a mere island of space. As we know them now, the Redwood (*Sequoia sempervirens*) lives only in a narrow strip of the coast ranges 10 to 30 miles wide, extending from just within the southern border of Oregon to the bay of Monterey, while the Big Tree (*Sequoia washingtoniana*) is found only in small groves scattered along the west slope of the Sierra Nevada Mountains, from the middle fork of the American River to the head of Deer Creek, a distance of 260 miles. The utmost search reveals but ten main groups, and the total number of sizable trees in these groups must be limited to figures in the thousands. It is, moreover, the plain truth that all the specimens which are remarkable for their size do not exceed 500.

The Big Trees are unique in the world—the grandest, the largest, the oldest, the most majestically graceful of trees—and if it were not enough to be all this, they are among the scarcest of known tree species and have the extreme scientific value of being the best living representatives of a former geologic age. It is a tree which has come down to us through the vicissitudes of many centuries solely because of its superb qualifications. Its bark is often 2 feet thick and almost noncombustible. The oldest specimens felled are still sound at the heart, and fungus is an enemy unknown to it. Yet with all these means of maintenance the Big Trees have apparently not increased their range since the glacial epoch. They have only just managed to hold their own on the little strip of country where the climate is locally favorable.

At the present time the only grove thoroughly safe from destruction is the Mariposa, and this is far from being the most interesting. Most of the other groves are either in process of, or in danger of, being logged. The very finest of all, the Calaveras Grove, with the biggest and tallest trees, the most uncontaminated surroundings, and practically all the literary and scientific associations of the species connected with it, has been purchased recently by a lumberman who came into full possession on the 1st of April, 1900. The Sequoia and General Grant National parks, which are supposed to embrace and give security to a large part of the remaining Big Trees, are eaten into by a sawmill each, and by private timber claims amounting to a total of 1,172.87 acres. The rest of the scanty patches of Big Trees are in a fair way to disappear—in Calaveras, Tuolumne, Fresno, and Tulare counties, they are now disappearing—by the ax. In brief, the majority of the Big Trees of California, certainly the best of them, are owned by people who have every right, and in many cases every intention, to cut them into lumber.

GENERAL FACTS.

First Grove Discovered.

The Calaveras Grove was the first one discovered, having been found in 1841 by John Bidwell, afterward candidate for member of Congress from California. But for some reason this discovery seems to have been generally credited to another person, as shown by the following story quoted from "In the Heart of the Sierras," by J. M. Hutchings:

> In the spring of 1852, Mr. A. T. Dowd, a hunter, was employed by the Union Water Company, of Murphy's, Calaveras County, to supply the workmen engaged in the construction of their canal with fresh meat, from the large quantities of game running wild on the upper portion of their works. While engaged in this calling, having wounded a grizzly bear, and while industriously pursuing him, he suddenly came upon one of those immense trees. * * *
>
> Returning to camp, he there related the wonders he had seen, when his companions laughed at him, and even questioned his veracity. * * *
>
> For a day or two he allowed the matter to rest; submitting, with chuckling satisfaction, to their occasional jocular allusions to "his big tree yarn," but continued hunting as formerly. On the Sunday morning ensuing, he went out early as usual, but soon returned * * * when he exclaimed, "Boys, I have killed the largest grizzly bear that I ever saw in my life. While I am getting a little something to eat, you make every preparation for bringing him in; all had better go that can be spared, as their assistance will certainly be needed."
>
> Nothing loath, they were soon ready for the start. * * * On, on they hurried, with Dowd as their guide, through thickets and pine groves; crossing bridges and canyons, flats, and ravines, each relating in turn the adventures experienced, or heard of from companions, with grizzly bears, and other formidable tenants of the mountains, until their leader came to a halt at the foot of the immense tree he had seen, and to them had represented the approximate size. Pointing to its extraordinary diameter and lofty height, he exultingly exclaimed, "Now, boys, do you believe my big tree story? That is the large grizzly I wanted you to see. Do you now think it a yarn?"

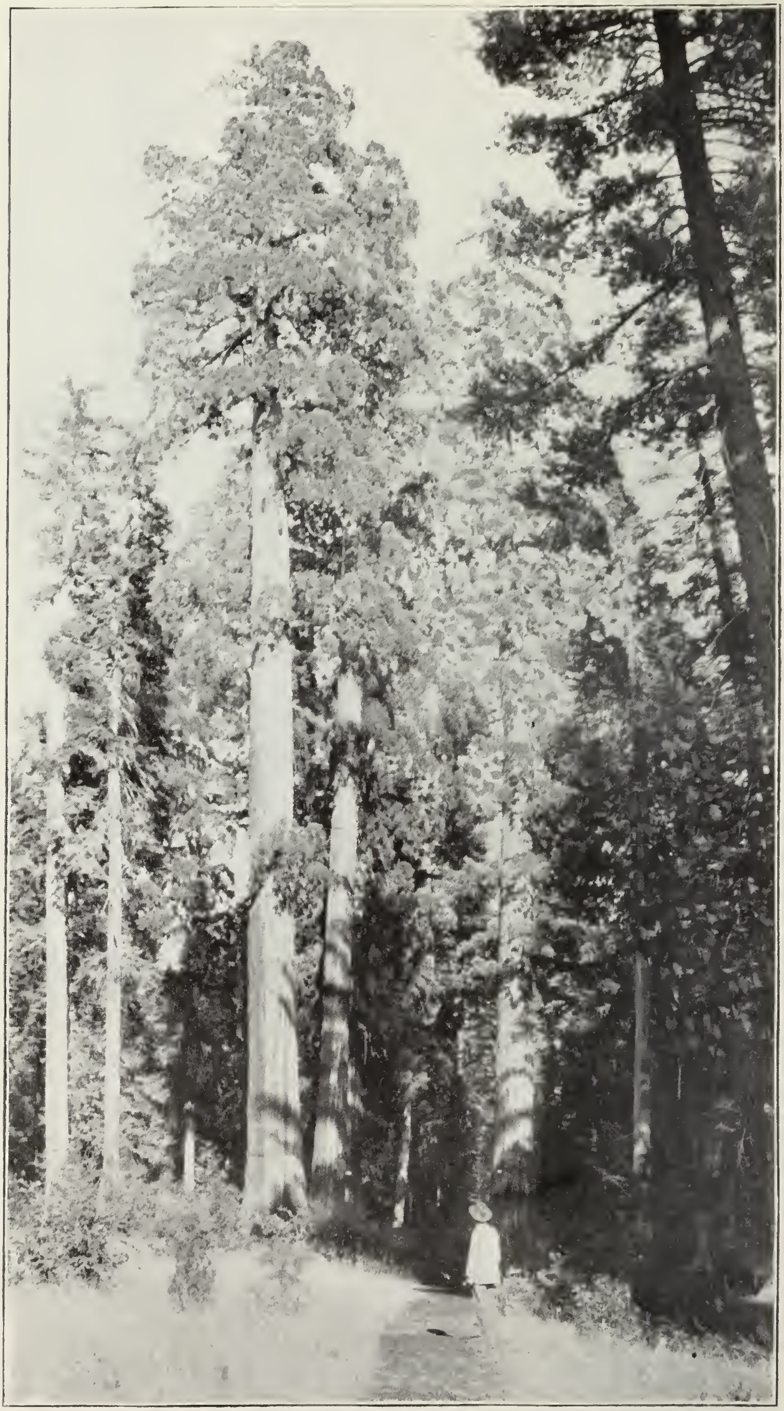
Discovery of Other Groves.

Just how and when the other groves of Big Trees were found is difficult to determine. As early as 1864 Professor Brewer, of Yale, and a party from the California Geological Survey visited the Calaveras and Mariposa groves and also several tracts in the region of Kings River, and by 1870 the majority of Big Trees had been located.

The following account of the different groves, which is in the main accurate and complete, is taken from J. D. Whitney's "Yosemite Guide-Book" (1870):

General Description and Location of Big Tree Groves.

The Big Tree occurs exclusively in "groves" or scattered over limited areas, never forming groups by themselves, but always disseminated among a much larger number of trees of other kinds. These patches on which the Big Trees stand do not equal in



CALAVERAS BIG TREE GROVE: EDGE OF GROVE, SHOWING THE "SENTINELS" AND THE RELATIVE HEIGHT OF OTHER ASSOCIATED FOREST TREES.

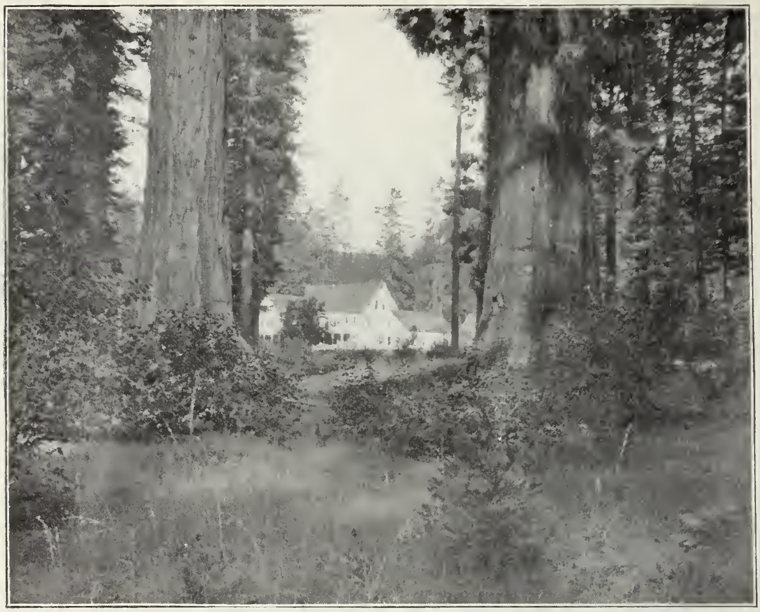


FIG. 1.—CALAVERAS BIG TREE GROVE: SPERRY'S HOTEL FROM ENTRANCE OF GROVE, WITH THE "SENTINELS" ON EITHER SIDE.

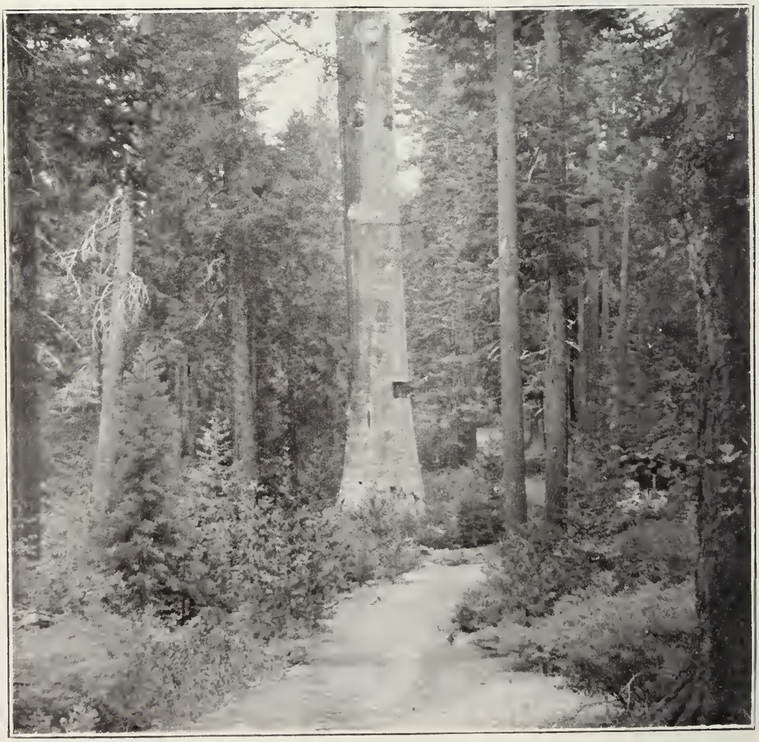
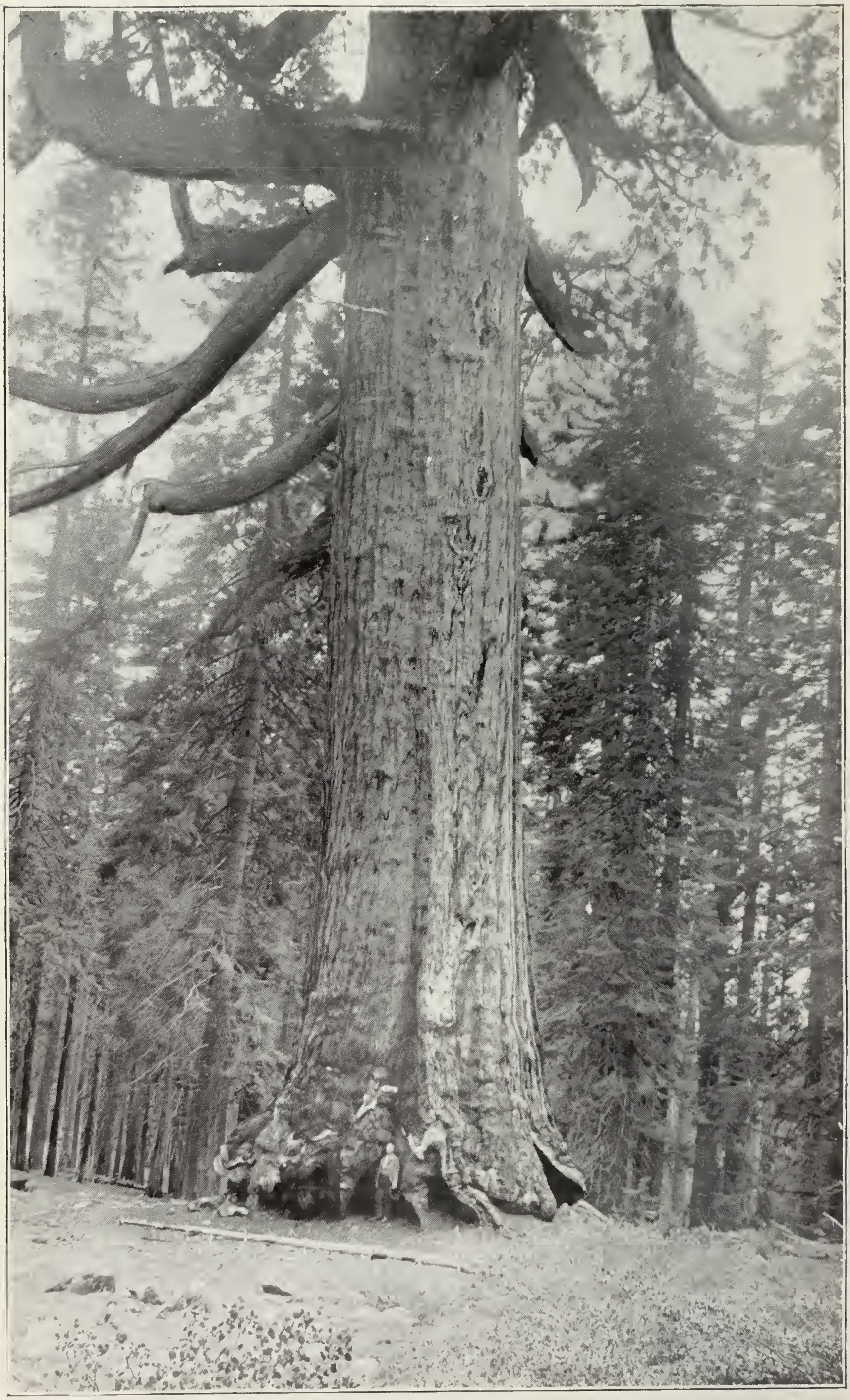
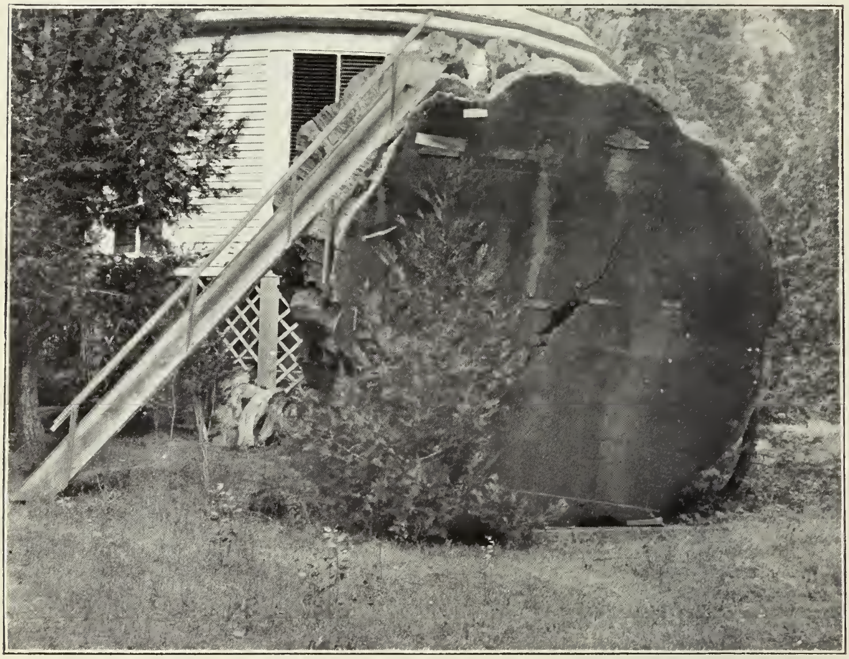


FIG. 2.—CALAVERAS BIG TREE GROVE, NORTH BORDER: ONE OF THE LARGEST BIG TREES BARKED MANY YEARS AGO FOR EXHIBITION PURPOSES; SUGAR PINE, YELLOW PINE, AND WHITE FIR IN VIEW.



THE "GRIZZLY GIANT" IN THE MARIPOSA BIG TREE GROVE.



Calaveras Big Tree Grove: Section of the Big Tree felled in 1854 by cutting off the Trunk with Augers; The Stump forms the Floor in the Building.

area a hundredth part of that which the redwoods cover exclusively. We are quite unable to state the number of square miles or acres on which the Big Trees grow, except for two of the groves, the Calaveras and Mariposa, both of which have been carefully surveyed by our parties. It may be roughly stated, however, that this area does not, so far as yet known, exceed 50 square miles, and that most of this is in one patch, between Kings and Kaweah rivers, as will be noticed farther on.

The Calaveras Grove is the most northerly, and one on the south fork of the Tule is the farthest south of any yet known to us. They are also quite limited in vertical range, since they nowhere descend much below 5,000 or rise above 7,000 feet. They follow the other trees of California, in this respect, that they occur lower down on the Sierra as we go northwards; the most northerly grove, that of Calaveras, is the lowest in elevation above the sea level.

There are eight [ten as now constituted] distinct patches or groves of the Big Trees—or nine, if we should consider the Mariposa trees as belonging to two different groups, which is hardly necessary, inasmuch as there is only a ridge half a mile in width separating the upper grove from the lower [now counted as one grove]. The eight groves are in geographical order from north to south: First, the Calaveras; second, the Stanislaus [or "South Calaveras" Grove]; third, Crane Flat [or Tuolumne Grove]; fourth, Mariposa; fifth, Fresno; sixth, Kings and Kaweah rivers; seventh, North Fork Tule River; eighth, South Fork Tule River.

Two small groves, the Merced and Dinky, and six trees, called the "North Grove," in southern Placer County, must be added to the above list. Mr. Whitney's description of the first eight groves is as follows:

CALAVERAS OR "MAMMOTH" GROVE.

The Calaveras Grove is situated in the county of that name, about 16 miles from Murphy's Camp, and near the Stanislaus River. It is on or near the road crossing the Sierra by the Silver Mountain Pass. This being the first grove of the Big Trees discovered, and the most accessible, it has come more into notice and been much more visited than any of the others; indeed, this and the Mariposa Grove are the only ones which have become a resort for travelers. The Calaveras Grove has also the great advantage over the others that a good hotel is kept there, and that it is accessible on wheels, all the others being at a greater or less distance from any road. (See Pls. I, II, IV, XIV, and XV.)

This grove occupies a belt 3,200 feet long by 700 feet broad, extending in a northwest and southeast direction, in a depression between two slopes, through which meanders a small brook which dries up in summer. There are between 90 and 100[1] trees of large size in the grove, and a considerable number of small ones, chiefly on the outskirts. Several have fallen since the grove was discovered, one has been cut down, and one has had the bark stripped from it up to the height of 116 feet above the ground. (See Pl. II, fig. 2.) The bark thus removed was exhibited in different places, and finally found a resting place in the Sydenham Crystal Palace [England], where it was unfortunately burned in the fire which consumed a part of that building a few years since. The two trees thus destroyed were perhaps the finest in the grove; the tallest now standing is the one called the "Keystone State;" the largest and finest is known as the "Empire State." The height of this grove above sea level is 4,759 feet.

STANISLAUS OR "SOUTH CALAVERAS" GROVE.

The next grove south of the one just noticed is south of the Stanislaus River, near the borders of Calaveras and Tuolumne counties. It has been described to us as being about 10 [now estimated to be 6] miles southeast of the Calaveras Grove, on Beaver Creek, a branch of the Stanislaus. It is said to contain from 600 to 800[2] trees, but none as large as those already described.

TUOLUMNE GROVE.

About 25 miles southeast of the last-mentioned grove is another, which may be called the Crane Flat Grove, as it is from a mile to a mile and a half from the station of that name on the Coulterville trail to the Yosemite, in a northwesterly direction. It was visited by our party in haste, and its extent was not ascertained nor the number of trees counted. They stand mostly on the north slope of a hill, rather sheltered from the wind, and, so far as observed, are rather smaller than those of the Calaveras Grove. The largest sound tree measured was 57 feet in circumference at 3 feet from the ground.. A stump so burned that only one-half remained was 23 feet in diameter, inside the bark at 3 feet from the ground.

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[1] The former owner of this grove, Mr. J. L. Sperry, gives the number as 101.

[2] The former owner, Mr. J. L. Sperry, places the number at 1,380.

A single Big Tree stands in the woods by itself somewhere southwest of the Crane Flat Grove, and between it and the Merced. It is the only instance, so far as we know, of the occurence of this species solitary and alone. There is an almost entirely unexplored region between the Beaver Creek and the Crane Flat groves, and there may possibly be some more Big Trees existing there and not yet discovered. It is about 20 miles, still in a southwesterly direction, from Crane Flat to the Mariposa Grove, and that region has been so thoroughly explored by the Survey, that there is no reason to suppose that any more of these trees will be found there.

MARIPOSA GROVE.

The Mariposa Grove is situated about 16 miles directly south of the Lower Hotel in the Yosemite Valley, and between 3 and 4 miles southeast of Clark's ranch, and at an elevation of about 1,500 feet above the last-named place, or of some 5,500 feet above the sea level. It lies in a little valley, occupying a depression on the back of a ridge which runs along in an easterly direction between Big Creek and the South Merced. One of the branches of the creek heads in the grove.

The grant made by Congress is 2 miles square, and embraces, in reality, two distinct or nearly distinct groves; that is to say, two collections of Big Trees between which there is an intervening space without any. The upper grove is in a pretty compact body, containing, on an area of 3,700 by 2,300 feet in dimensions, just 365 trees of the *Sequoia gigantea* of a diameter of 1 foot and over, besides a great number of small ones. The lower grove, which is smaller in size and more scattered, lies in a southwesterly direction from the other, some trees growing quite high up in the gulches on the south side of the ridge which separates the two groves.

The principal trees associated with the Big Trees in this grove are the pitch and sugar pines, the Douglas spruce, the white fir (*Picea grandis*) [now *Abies concolor*], and the bastard cedar (*Libocedrus decurrens*).

There are but very few of the young Big Trees growing within the grove, where probably they have been destroyed by fire. Around the base of several of the large trees on the outskirts of the grove there are small [natural] plantations of young Sequoias of all sizes up to 6 or 8 inches in diameter, but only a few as large as this. Those trees which are about 10 feet in diameter and entirely uninjured by fire, in the full symmetry of a vigorous growth of say 500 years, are, although not as stupendous as the older giants of the forest, still exceedingly beautiful and impressive.

The southern division of the Mariposa Grove, or Lower Grove, as it is usually called, is said to contain about half as many (182) trees as the one just described. They are much scattered among other trees, and do not, therefore, present as imposing an appearance as those in the other grove, where quite a large number can often be seen from one point. The largest tree in the lower grove is the one known as the "Grizzly Giant," which is 93 feet 7 inches in circumference at the ground, and 64 feet 3 inches at 11 feet above. (See Pl. III.) Its two diameters at the base, as near as we could measure, were 30 and 31 feet. The calculated diameter at 11 feet above the ground is 20 feet, nearly. The tree is very much injured and decreased in size by burning, for which no allowance has been made in the above measurements. Some of the branches of this tree are fully 6 feet in diameter, or as large as the trunks of the largest elms in the Connecticut Valley, of which Dr. Holmes has so pleasantly discoursed in the Atlantic Monthly. This tree, however, has long since passed its prime, and has the battered and war-worn appearance conveyed by its name.

FRESNO GROVE.

The next grove south of the Mariposa is one in Fresno County, about 14 miles southeast of Clark's, and not far from a conspicuous point called Wammelo Rock. Mr. Clark has described this grove, which we had not visited, as extending for above 2½ miles in length by from 1 to 2 in breadth. He has counted 500 trees in it, and believes the whole number to be not far from 600. The largest measured 81 feet in circumference at 3 feet from the ground.

No other grove of Big Trees has been discovered to the southeast of this along the slope of the Sierra, until we reach a point more than 50 miles distant from the Fresno Grove. Here, between the Kings and Kaweah rivers, is by far the most extensive collection of trees of this species which has yet been discovered in the State.

KINGS RIVER AND KAWEAH RIVER GROVE.

This belt of trees, for grove it can hardly be called, occurs about 30 miles north-northeast of Visalia, on the tributaries of the Kings and Kaweah rivers, and on the divide between. They are scattered over the slopes and on the valleys, but are larger in the depressions, where the soil is more moist. Along the trail which runs from Visalia to the Big Meadows, the belt is 4 or 5 miles wide, and it extends over a vertical range of about 2,500 feet; its total length is as much as 8 or 10 miles, and maybe more. The trees are not collected together into groves, but are scattered through the forests, and associated with the other species usually occurring at this altitude in the Sierra. They are most abundant at from 6,000 to 7,000 feet elevation above the sea level. Their number is great; probably thousands might be counted. Their size, however, is not great, the average being from 10 to 12 feet in diameter, and but few exceeding 20 feet; but smaller ones are very numerous. One tree, which had been cut, had a diameter of 8 feet, exclusive of the bark, and was 377 years old. The largest one seen was near Thomas's Mill; this had a circumference of 106 feet near the ground, no allowance being made for a portion which was burned away at the base. When entire the tree may have been 10 or 12 feet more in circumference. At about 12 feet from the ground the circumference was 75 feet. Its height was 276 feet. The top was dead, however, and, although the tree was symmetrical and in good growth, it had passed its prime.

Another tree, which had fallen, and had been burned hollow, was so large, that three horsemen could ride abreast into the cavity for a distance of 30 feet, its height and width being about 11 feet. At a distance of 70 feet the diameter of the cavity was still as much as 8 feet. The base of this tree could not be easily measured, but the trunk was burned through at 120 feet from the ground, and at that point had a diameter (exclusive of the bark) of 13 feet 2 inches; and at 169 feet from its base the tree was 9 feet in diameter. The Indians stated that a still larger tree existed to the north of Kings River. This tree should be looked up and carefully measured; unfortunately, it was not in the power of our party to do this.

All through these forests there are numerous young Big Trees, of all sizes, from the seedling upward, and at Thomas's Mill they are cut up for lumber in a manner quite at variance with the oft-repeated story of the exceptional character of the species. Prostrate trunks of old trees are also numerous; some of them must have lain for ages, as they were nearly gone, while the wood is very durable.

TULE RIVER GROVES.

The only other groves yet discovered are those on the Tule River, of which there are two, one on the north and the other on the south branch of that stream. They are 15 miles apart, and the most northerly of the two is about 30 miles from the grove last described. As the intervening region has been but little explored, it is not at all unlikely that more of the Big Trees may be found along the fork of the Kaweah which intersects this region with its numerous branches. We are not aware that these two Tule groves were known previous to their discovery by Mr. D'Heureuse, one of the topographers of the Geological Survey, in 1867; at least, no notice of them had ever appeared in print. The number of trees in these groves is quite large, as they are scattered over several square miles of area. The largest of them were said by Mr. D'Heureuse to be about the size of the largest in the other groves.

DINKY AND MERCED GROVES.

Very little reliable information is obtainable at present concerning these groves. The Dinky Grove is located on Dinky Creek, one of the north tributaries of Kings River, and is said to have been accidentally discovered by two hunters in the early seventies. It is also said to contain only a small number of trees.

The Merced Grove is a small group located on and near the headwaters of the Merced River, and reported to contain less than 100 trees.

THE NORTH GROVE.

This can hardly be called a grove, but is so named for uniformity of designation with other larger groups. It comprises six living trees, and is located in southern Placer County, on a tributary stream of the middle fork of the American River. The elevation of the grove is 5,100 feet above sea level. The grove is about 20 miles southeast of Red Point Mine, on the Forest Hill Divide, and about 15 miles west of the mining camp, Michigan Bluff, from both of which points the trees can be reached by trail. The grove is about 70 miles north of the Calaveras or "Mammoth" Big Tree Grove.

This grove is said to have been discovered by an old miner, Joe Matlock, in 1855. It appears also to have been long known to the settlers of the region, as shown by the dates 1860 to 1890 cut into the smooth-barked alders near the Big Trees. But the first authentic account of this grove was published by W. W. Price in the January issue of the Sierra Club Bulletin for 1893.

Of the six trees comprising the grove, only two are of large size. These are respectively 220 and 240 feet high and 12 and 10 feet in diameter at 4 feet from the ground. The other trees are about 180 feet high and 3 feet in diameter.

A few small Big Trees in this grove have been blown down, and one quite large tree is said to have gone down subsequent to 1885. About 200 feet of the trunk is still intact. The full height is not known, as the top of the tree was broken off before the trunk fell. The diameter at the roots of the tree was 20 feet. One other large dead tree, 28 feet in diameter, is said to have been blown down in 1855, but the trunk has since disappeared—probably by forest fires, which have frequently raged through the region.

History and Size of Notable Big Trees.

CALAVERAS OR "MAMMOTH" GROVE.

The history and figures showing the size of notable Big Trees in this grove occur in the following extracts.

DEAD TREES.

In 1853 one of the largest trees was cut down. It is said to be the original tree discovered by John Bidwell (or by A. T. Dowd, as the more current story has it).

Its diameter across the solid wood, after the bark was removed (and which was from 15 to 18 inches in thickness), is 25 feet, although the tree was cut off 6 feet above the ground. However incredible it may appear, on July 4, 1854, the writer[1] formed one of a cotillion party of 32 persons dancing upon this stump, in addition to which the musicians and lookers-on numbered 17, making a total of 49 occupants on its surface at one time. The accompanying sketch was made at that time, and, of course, before the present pavilion was erected over it. There is no more srikingly convincing proof, in any grove, of the immense size of the Big Trees, than this stump. [See Pl. IV.]

This tree was 302 feet in height, and, at the ground, 96 feet in circumference, before it was disturbed. Some sacrilegious vandals, from the motive of making its exposition "pay," removed the bark to the height of 30 feet; and afterwards transported it to England, where it was formed into a room; but was afterwards consumed by fire with the celebrated Crystal Palace at Kensington, England. This girdling of the tree very naturally brought death to it; but even then its majestic form must have perpetually taunted the belittled and sordid spirits that caused it. It is, however, but an act of justice to its present proprietor, Mr. James L. Sperry,[2] to state that, although he has been the owner of the grove for over twenty years, that act of vandalism was perpetrated before he purchased it, or it would never have been permitted.

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[1] J. M. Hutchings in "In the Heart of the Sierras."

[2] Mr. Sperry has recently sold this grove to a lumberman, as stated in the introduction.

Mr. Hutchings[1] describes the felling of this tree as follows:

> The next act in this botanical tragedy was the cutting down of the tree, in order to accommodate those who wished to carry home specimens of its wood as souvenirs of their visit. But how to do this was the puzzling conundrum! If one could fittingly imagine so ludicrous a sight as a few lilliputian men attempting to chop down this brobdingnagian giant, his contempt would reach its becoming climax. This, therefore, was given up as altogether too chimerical and impracticable. Finally, the plan was adopted of boring it off with pump augers. This employed five men twenty-two days to accomplish; and after the stem was finally severed from the stump, the uprightness of its position, and breadth of its base, prevented its overthrow; so that two and a half of the twenty-two days were spent in inserting wedges, and driving them into the butt of the tree, by logs suspended on ropes, thereby to compel its downfall. While these slow and apparently hopeless attempts were being undertaken, and the workmen had retired for dinner, a gust of wind took hold of its top, and hurled it over without the least seeming effort; its fall causing the earth to tremble as by an earthquake. Thus this noble monarch of the forest was dethroned after "braving the battle and the breeze" for nearly two thousand years. Verily, how little real veneration does the average man possess.
>
> *The Mother of the Forest.*—In this grove once stood a most beautiful tree, graceful in form and unexcelled in proportions; hence (as in human experience) those very qualities at once became the most attractive to the eyes of the unfeeling spoliator. This bore the queenly name of The Mother of the Forest.
>
> In the summer of 1854, the bark was stripped from its trunk, by a Mr. George Gale, for purposes of exhibition in the East, to the height of 116 feet. (See Pl. II, fig. 2.) It now measures in circumference, at the base, without the bark, 84 feet; 20 feet from base, 69 feet; 70 feet from base, 43 feet 6 inches; 116 feet from base, and up to the bark, 39 feet 6 inches. The full circumference at base, including bark, was 90 feet. Its height was 321 feet. The average thickness of bark was 11 inches, although in places it was about 2 feet. This tree is estimated to contain 537,000 feet of sound inch lumber. To the first branch it is 137 feet.
>
> The small black marks upon the tree indicate points where 2½-inch auger holes were bored, and into these rounds were inserted, by which to ascend and descend while removing the bark. At different distances upward, especially at the top, numerous dates and names of visitors have been cut. It is contemplated to construct a circular stairway around this tree. When the bark was being removed, a young man fell from the scaffolding—or rather out of a descending noose—at a distance of 79 feet from the ground, and escaped with a broken limb. The writer was within a few yards of him when he fell, and was agreeably surprised to discover that he had not broken his neck.
>
> *The Father of the Forest.*—But a short distance from this [The Mother of the Forest] lies the prostrate form of one that was probably the tallest Sequoia that ever grew—The Father of the Forest. This tree, when standing in its primitive majesty, is accredited with exceeding 400 feet in height, with a circumference at its base of 110 feet; and, although limbless, without bark, and even much of its sap [wood] decayed and gone, has still proportions that once could crown him king of the grove. In falling it struck against "Old Hercules," another old-time rival in size, by which the upper part of his trunk was shivered into fragments, that were scattered in every direction. While fire has eaten out the heart of "The Father of the Forest," and consumed his huge limbs, as of many others, the following measurements, recently taken, will prove that he was among the giants of those days, and that "even in death still lives." From the roots, to where the center of the trunk can be reached on horseback, it is 90 feet. The distance that one can ride erect through it on horseback is 82 feet 6 inches. Height of entrance, 9 feet 4 inches; of arch to floor, 10 feet 9 inches. Across the roots it is 28 feet; to where one would have an idea of standing to chop it down, 23 feet 2 inches; 10 feet from the roots its diameter is 20 feet 8 inches; 100 feet from roots, 12 feet 1 inch; 150 feet from roots, 10 feet 4 inches; extreme length, to where any sign of top can be found, 365 feet.
>
> But no one can approximately realize the immense proportions of this prostrate forest sire, without climbing to its top, and walking down it for its entire length; by this, moreover, he will ascertain that it was nearly 200 feet to the first branch. At the end of the burnt cavity within, is a never-failing spring of deliciously cool water.

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[1] J. M. Hutchings in "In the Heart of the Sierras."

The handsome group of stately trees that encompass the "Father of the Forest," make it an imposing family circle, and probably assisted in originating the name.

And this is only one of the numerous vegetable giants that Time's scythe has laid low, for near here lies "Old Hercules," the largest standing tree in the grove until 1862, then being 325 feet in height by 95 feet in circumference, at the ground; this was blown down that year during a heavy storm; "The Miner's Cabin," 319 feet long by 21 in diameter, thrown over by a gale in 1860; and "The Fallen Monarch," which has probably been down for centuries.

This trunk is still 18 feet in diameter, and was probably over 300 feet high and 25 or more feet in diameter.

LIVING TREES.

The following list[1] includes the notable living trees in the Calaveras Grove. Most of them are marked with marble tablets, which bear the names of States, distinguished statesmen, generals, and scholars.

The "Two Sentinels," over 300 feet high, the larger 23 feet in diameter. [See Pl. I and Pl. II, fig. 1.]
"U. S. Grant," named in 1865.
"W. T. Sherman," named in 1865.
"J. B. McPherson," named in 1865.
"Pride of the Forest," once named "The Eagle;" 300 feet high and 23 feet in diameter.
"Phil Sheridan," 300 feet high.
"Three Graces," standing in close line and the most beautiful cluster in the grove.
"Andrew Johnson," named in 1865.
"Florence Nightingale," once named "Nightingale;" named in 1865 by a nephew of the English lady.
"Bay State."
"W. C. Bryant," named in 1865 by a lady, an admirer of the poet.
"W. H. Seward."
"Pioneer's Cabin," named from the cabin-like chamber and chimney formed by its hollow trunk.
"Pluto's Chimney," 280 feet high and 17 feet in diameter; hollowed out on one side by fire for 90 feet above ground.
"Quartette," a cluster of four trees, the tallest, 220 feet.
"America," 280 feet high and 13 feet in diameter; named in 1865 by a San Francisco lady.
"California," once called "Ada;" named in 1865.
"Broderick," once called "Mary;" named in 1865.
"Henry Ward Beecher," 280 feet high and 14 feet in diameter.
"Abraham Lincoln," once called "Hermit;" 320 feet high and 18 feet in diameter.
"Elihu Burritt."
"Uncle Sam."
"Alta (Upper) California."
"Union."
"General Wadsworth."
"The Twins."
} Average height, 260 feet; average diameter, 15 feet.
"General Sutter." The trunk divides at 30 feet above ground and forms two trunks, each 280 feet high.
"Salem Witch."
"Longfellow."
"Prof. Asa Gray."
"Dr. John Torrey."
} Named in honor of distinguished American botanists.
"The Trinity"; three trees from one trunk, the circumference of which is 60 feet.
"Starr King," 360 feet high.
"Richard Cobden."
"John Bright."
"Daniel O'Connel."
"Edward Everett."
"Keystone State."
"Sir John Franklin."
"Dr. Kane."
} Named in 1862 by Lady Franklin.

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[1] Compiled from Nelson's "Atlantic and Pacific Tourists' Guide."

"Century"; named in 1865 in honor of The Century Association, of New York, of which the poet Bryant was president.

"John LeConte."
"Joseph LeConte." } Standing close together.
"Sequoia Queen."
"Maids of Honor." } A cluster of three, the "Queen" in the center.
"Sir Joseph Hooker"; named in honor of the English botanist.
"John Lindley"; named in honor of the English botanist who was the first to name and describe the Big Tree.
"Mother and Son"; a large and small tree together.
"General Scott," 325 feet high.
"Old Bachelor."
"Kentucky."
"The Siamese Twins."
"Daniel Webster."
"Granite State." } Average height, 305 feet; average diameter, 20 feet.
"The Old Republican."
"Henry Clay."
"Andrew Jackson."
"Vermont."
"Empire State," 94 feet in circumference.
"Old Dominion."
"George Washington."
"Uncle Tom's Cabin."
"The Beauty of the Forest."

The following table gives additional measurements for some of the above-named Big Trees in the Calaveras Grove. These figures are believed to be conservative and to express more nearly the actual sizes of the trees named:

Height and diameter measurements of trees in the Calaveras Grove.[1]

Name of tree.	Diameter 6 feet above ground.	Height.
	Feet.	*Feet.*
Keystone State	14.3	325
General Jackson	12.7	319
Mother of the Forest (without bark)	19.4	315
Daniel Webster	15	307
T. Starr King	16.6	283
Richard Cobden	13.1	284
Pride of the Forest	15.3	282
Henry Clay	15	280
Bay State	14.6	275
James King of William	16.2	274
Sentinel	15.6	272
Dr. Kane	15.9	271
Arborvitæ Queen	9.6	269
Abraham Lincoln	14	268
Maid of Honor	8.6	266
Old Vermont	12.7	265
Uncle Sam	13.7	265
Mother and Son (Mother)	16.2	261
Three Graces (highest)	9.6	262
William Cullen Bryant	15.3	262
U. S. Grant	10.8	261
George Washington	16.2	256
General Scott	13.7	258
Henry Ward Beecher	10.8	252
California	10.5	250
Uncle Tom's Cabin	15.9	250
Beauty of the Forest	12.4	249
J. B. McPherson	9.9	246
Florence Nightingale	11.8	246
James Wadsworth	8.6	239
Elihu Burritt	9.9	231

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[1] From J. D. Whitney's "Yosemite Guide-Book." For a readier conception of size, Mr. Whitney's circumference measurements are here converted into equivalent diameters.

These measurements will have a new value when it is remembered that they are now nearly 40 years old—old enough to make remeasurement very interesting for comparison.

STANISLAUS OR "SOUTH CALAVERAS" GROVE.

This grove contains 1,380 Big Trees, ranging in diameter from 1 foot to 34 feet.

Mr. Hutchings describes the trees of note in this grove as follows:

> The large number of these immense trees, from 30 feet to over 100 feet in circumference, at the ground, and in almost every position and condition, would become almost bewildering were I to present in detail each and every one; a few notable examples, therefore, will suffice as representatives of the whole. (See Pl. V.)
>
> The first Big Tree that attracts our attention, and which is seen from the ridge north of the Stanislaus River, is the "Columbus," a magnificent specimen, with three main divisions in its branches, and standing alone. Passing this we soon enter the lower end of the South Grove[1] and arrive at the "New York," 104 feet in circumference, and over 300 feet in height. Near to this is the "Correspondent," a tree of stately proportions, named in honor of the "Knights of the Quill." The "Ohio" measures 103 feet in circumference, and is 311 feet in height. The "Massachusetts" is 98 feet, with an altitude of 307.
>
> Near to a large black stump, above this, stands a tree that is 76 feet in circumference, that has been struck by lightning, 170 feet from its base; where its top was shivered into fragments, and hurled in all directions for over 100 feet from the tree; the main stem being rent from top to bottom, the apex of this dismantled trunk being 12 feet in diameter. The "Grand Hotel" is burned out so badly that nothing but a mere living shell is left. This will hold 40 persons. Then comes the "Canal Boat;" which, as its name implies, is a prostrate tree; the upper side and heart of which have been burned away, so that the remaining portion resembles a huge boat; in the bottom of which thousands of young Big Trees have started out in life; and, if no accident befalls them, in a thousand or two years hence, they may be respectable-sized trees, that can worthily take the places of the representatives of this noble genus, and, like these, challenge the admiring awe of intellectual giants of that day and age. (See Pl. V, fig. 1.)
>
> "Noah's Ark" was another prostrate shell that was hollow for 150 feet; through which, for 60 feet, three horsemen could ride abreast; but the snows of recent winters have broken in its roof, and blocked all further passage down it. Next comes the "Tree of Refuge," where, during one severe winter, 16 cattle took shelter; but subsequently perished from starvation. They found protection from the storm, but their bleaching bones told the sad tale of their sufferings and death from lack of food. Near to this lies "Old Goliath," the largest decumbent tree in the grove; whose circumference was over 100 feet, and, when erect, was of proportionate height to the tallest. During the gale that prostrated "Hercules," in the Calaveras Grove, this grand old tree had also to succumb. One of his stalwart limbs was 11 feet in diameter.
>
> #### SMITH'S CABIN.
>
> There is another notable specimen, which somewhat forms a sequel to the above, known as Smith's Cabin, on account of its having been the chosen residence of a trapper and old mountaineer named A. J. Smith—Andrew Jackson Smith—who made the charred hollow of this burnt-out tree hi lonely home for three years. (See Pl. VI.) There is no telling what these old denizens of the mountains can or will do when they have made up their minds to anything. The diameter of his cabin—which was to him a bedroom, sitting room, kitchen, and sometimes, during stormy weather, a stable for his horse—was 21 feet by 16. * * * On one occasion a regular "southeaster" was on the rampage, hurling down trees, twisting off branches, tossing about tree tops, and limbs, in all directions. As the old trapper dare not venture out, he sat listening, with unquestionable interest, to ascertain whether the wind or "Smith's Cabin" was becoming the better wrestler of the two. At this juncture an earth-trembling crash came with nerve-testing force, that made his hair stand on end, when he jumped to his feet, using certain emphatic words (the synonyms of which can be found in "holy writ," or elsewhere), thinking, as he afterwards expressed it, "that it

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[1] So called by many from its position immediately southeast of the Calaveras Grove, which is often called "North Grove."

was all u-p with him." As this was the downfall of "Old Goliath," he began to fear that old Boreas was getting the best of the match, if he did not claim the gate-money, and that "Smith's Cabin" would be the next giant thrown. But, being a brave man—and who could live such a life as his if he were not?—and knowing well that he could not do better, concluded to look this danger unquailingly in the face, as he had done many a one before it, stay where he was, and take the best, or worst, that might befall him.

MARIPOSA GROVE.

From the following table it will be seen that there are several trees in this grove larger than any in the Calaveras, and that their average size is greater. The average height of the Mariposa trees, however, is less than that of the Calaveras; and the highest of the former, 272 feet, is 53 feet less than the tallest one of the latter. There is a burned stump on the north side of the grove, nearly all gone, but indicating a tree of a size perhaps a little greater than any now existing there. The beauty of the Mariposa Grove has been sadly marred by the ravages of fire, which has evidently swept through it again and again, almost ruining many of the finest trees. Still, the general appearance of the grove is extremely grand and imposing. There are about 125 trees over 40 feet in circumference.[1] (See Pls. VII and VIII.)

Height and diameter measurements of trees in the Mariposa Grove.[2]

No.	Height.	Diameter at ground.	Diameter at 6 feet above the ground.	Remarks.
	Feet.	*Feet.*	*Feet.*	
6	....	24.7	....	
7	....	23.1	....	
11	....	19.8	....	
12	244	19.8	....	
15	272	....	....	
16	....	27.6	....	Hollow.
20	....	23.1	17.5	
21	....	....	14.0	
27	250	15.3	....	
29	....	28.6	....	
31	186	11.4	9.4	
35	....	20.7	16.2	
38	226	8.6	....	
49	194	....	....	
51	218	17.8	12.4	
52	249	....	12.7	
60	....	26.0	18.8	Burned at base.
64	....	26.0	15.9	
66	221	12.7	....	
69	219	11.4	....	
70	225	14.0	....	
77	197	....	8.8	
102	255	....	15.9	
158	223	....	....	
164	243	....	8.8	
169	....	25.4	....	Much burned at base.
171	....	26.3	....	Badly burned on one side.
174	268	....	13.0	
194	192	....	14.6	Two trees, united at the base.
205	229	28.0	....	Much burned on one side; formerly over 100 feet in circumference.
206	235	22.4	....	
216	....	....	20.1	Much burned at base.
226	219	....	15.3	
236	256	....	14.6	
238	....	....	18.2	Burned on one side.
239	187	....	8.5	
245	270	26.0	21.4	Do.
253	....	23.7	19.1	
262	....	17.8	....	Half burned away at base.
275	....	21.0	....	
286	....	24.2	....	Burned on one side nearly to center.
290	....	....	14.6	
301	....	....	16.2	
304	260	29.5	....	All burned away on one side.
330	....	29.2	....	
348	227	....	16.2	

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[1] From J. D. Whitney's "Yosemite Guide-Book."

[2] Compiled from J. D. Whitney's "Yosemite Guide-Book" (1870).

THE BEAUTY OF BIG TREES AND THEIR ENVIRONMENT.

The beauty of the Big Trees and their surroundings is nowhere more vividly described than in Mr. John Muir's "Mountains of California." He says:

So exquisitely harmonious and finely balanced are even the very mightiest of these monarchs of the woods in all their proportions and circumstances there never is anything overgrown or monstrous-looking about them. On coming in sight of them for the first time, you are likely to say, "Oh, see what beautiful, noble-looking trees are towering there among the firs and pines!" their grandeur being in the meantime in great part invisible, but to the living eye it will be manifested sooner or later, stealing slowly on the senses, like the grandeur of Niagara, or the lofty Yosemite domes. Their great size is hidden from the inexperienced observer as long as they are seen at a distance in one harmonious view.

When, however, you approach them and walk round them, you begin to wonder at their colossal size and seek a measuring rod. These giants bulge considerably at the base, but not more than is required for beauty and safety; and the only reason that this bulging seems in some cases excessive is that only a comparatively small section of the shaft is seen at once in near views. One that I measured in the Kings River forest was 25 feet in diameter at the ground, and 10 feet in diameter 200 feet above the ground, showing that the taper of the trunk as a whole is charmingly fine. And when you stand back far enough to see the massive columns from the swelling instep to the lofty summit dissolving in a dome of verdure, you rejoice in the unrivaled display of combined grandeur and beauty. About 100 feet or more of the trunk is usually branchless, but its massive simplicity is relieved by the bark furrows, which instead of making an irregular network run evenly parallel, like the fluting of an architectural column, and to some extent by tufts of slender sprays that wave lightly in the winds and cast flecks of shade, seeming to have been pinned on here and there for the sake of beauty only.

The young trees have slender, simple branches down to the ground, put on with strict regularity, sharply aspiring at the top, horizontal about half way down, and drooping in handsome curves at the base. By the time the sapling is five or six hundred years old this spiry, feathery, juvenile habit merges into the firm, rounded, dome form of middle age, which in turn takes on the eccentric picturesqueness of old age. No other tree in the Sierra forest has foliage so densely massed or presents outlines so firmly drawn and so steadily subordinate to a special type. A knotty ungovernable-looking branch 5 to 8 feet thick may be seen pushing out abruptly from the smooth trunk, as if sure to throw the regular curve into confusion, but as soon as the general outline is reached it stops short and dissolves in spreading bosses of law-abiding sprays, just as if every tree were growing beneath some huge, invisible bell glass, against whose sides every branch was being pressed and molded, yet somehow indulging in so many small departures from the regular form that there is still an appearance of freedom.

The foliage of the saplings is dark bluish green in color, while the older trees ripen to a warm brownish-yellow tint like Libocedrus. The bark is rich cinnamon brown, purplish in young trees and in shady portions of the old, while the ground is covered with brown leaves and burs, forming color masses of extraordinary richness, not to mention the flowers and underbrush that rejoice about them in their seasons. Walk the Sequoia woods at any time of year and you will say that they are the most beautiful and majestic on earth. Beautiful and impressive contrasts meet you everywhere; the colors of tree and flower, rock and sky, light and shade, strength and frailty, endurance and evanescence, tangles of supple hazel bushes, tree pillars about as rigid as granite domes, roses and violets, the smallest of their kind, blooming around the feet of the giants, and rugs of the lowly Chamæbatia where the sunbeams fall. Then in winter the trees themselves break forth in bloom, myriads of small four-sided staminate cones crowd the ends of the slender sprays, coloring the whole tree, and when ripe dusting the air and the ground with golden pollen.

The fertile cones are bright grass-green, measuring about 2 inches in length by 1½ in thickness, and are made up of about 40 firm rhomboidal scales densely packed, with from 5 to 8 seeds at the base of each. A single cone, therefore, contains from 200 to 300 seeds, which are about a fourth of an inch long by three-sixteenths wide, including a thin, flat margin that makes them go glancing and wavering in their fall like a boy's kite. The fruitfulness of Sequoia may be illustrated by two specimen branches 1½ and 2 inches in diameter on which I counted 480 cones. No other Sierra conifer produces nearly so many seeds. Millions are ripened annually by a single tree, and in a fruitful year the product of one of the northern groves would be enough to plant all the mountain ranges of the world." But very few of the millions of seeds which fall to the ground germinate, "and of those that do perhaps not 1 in 10,000 is suffered to live through the many vicissitudes of storm, drought, fire, and snow-crushing that beset their youth."

AGE OF THE BIG TREES.

The extreme age attained by the Big Tree is still an unsettled question. Statements on the subject vary considerably, some appearing to be exaggerations. One great difficulty, however, in settling the question of age, at least for existing trees, is the lack of a proper number of trunk sections on which to count the rings of annual growth, thus giving unquestionable data on age.

Ring countings from prostrate and burned or decayed trunks and sections of trees felled for other purposes than ring counting, have largely furnished the basis of the age estimates made so far, and from these countings age estimates have been made for trees of other sizes which could not of course be cut down.

These generalizations not being based on ring countings from a series of trunk sections representing the full range in diameter of all trees now known, the statements as to the extreme age possible for these trees are necessarily approximative. It is the opinion of Mr. Hutchings that the average rate of growth is 1 inch of diameter for every twelve years, which would make a tree 25 feet through 3,600 years old. Mr. Muir's observations also roughly corroborate this theory. He writes:

> Under the most favorable conditions these giants probably live 5,000 years or more, though few of even the larger trees are more than half as old. I never saw a Big Tree that had died a natural death; barring accidents they seem to be immortal, being exempt from all the diseases that afflict and kill other trees. Unless destroyed by man they live on indefinitely until burned, smashed by lightning, or cast down by storms, or by the giving way of the ground on which they stand. The age of one that was felled in the Calaveras Grove, for the sake of having its stump for a dancing floor, was about 1,300 years, and its diameter, measured across the stump, 24 feet inside the bark. Another that was cut down in the Kings River forest was about the same size, but nearly a thousand years older (2,200 years), though not a very old-looking tree. It was felled to procure a section for exhibition, and thus an opportunity was given to count its annual rings of growth. The colossal scarred monument in the Kings River forest mentioned above is burned half through, and I spent a day in making an estimate of its age, clearing away the charred surface with an ax and carefully counting the annual rings with the aid of a pocket-lens. The wood-rings in the section I laid bare were so involved and contorted in some places that I was not able to determine its age exactly, but I counted over 4,000 rings, which showed that this tree was in its prime, swaying in the Sierra winds, when Christ walked the earth. No other tree in the world, as far as I know, has looked down on so many centuries as the Sequoia, or opens such impressive and suggestive views into history.

These estimates are confirmed by the most recent investigations on the age of the Big Tree.

GEOLOGIC HISTORY OF THE BIG TREE.

Perhaps more impressive even than the size or age of the Big Tree is the past life of the species. As already stated, the fossils show the present survivor to be the remnant of a once numerous family. Dr. Asa Gray writes:

> The same Sequoia which abounds in the same Miocene formations in Northern Europe has been abundantly found in those of Iceland, Spitzbergen, Greenland,

Mackenzie River, and Alaska. It is named *S. Langsdorfii*, but is pronounced to be very much like *S. sempervirens*, our living redwood of the California coast, and to be the ancient representative of it. Fossil specimens of a similar, if not the same, species have been recently detected in the Rocky Mountains by Hayden, and determined by our eminent paleontological botanist, Lesquereux; and he assures me that he has the common redwood itself from Oregon, in a deposit of tertiary age. Another Sequoia (*S. Sternbergii*), discovered in miocene deposits in Greenland, is pronounced to be the representative of *S. gigantea*, the Big Tree of the Californian Sierra. If the Taxodium of tertiary time in Europe and throughout the arctic regions is the ancestor of our present bald cypress, which is assumed in regarding them as specifically identical, then I think we may, with our present light, fairly assume that the two redwoods of California are the direct or collateral decendants of the two ancient species which so closely resemble them.

The forests of the arctic zone in tertiary times contained at least three other species of Sequoia, as determined by their remains, one of which, from Spitzbergen, also much resembles the common redwood of California. Another, "which appears to have been the commonest coniferous tree on Disco," was common in England and some other parts of Europe. So the Sequoias, now remarkable for their restricted station and numbers, as well as for their extraordinary size, are of an ancient stock; their ancestors and kindred formed a large part of the forests which flourished throughout the polar regions, now desolate and ice clad, and which extended into the low latitudes in Europe. On this continent one species at least had reached to the vicinity of its present habitat before the glaciation of the region. Among the fossil specimens already found in California, but which our trustworthy paleontological botanist has not yet had time to examine, we may expect to find evidence of the early arrival of these two redwoods upon the ground which they now, after much vicissitude, scantily occupy.

NATURAL REPRODUCTION OF THE BIG TREE.

It may be said that the north groves of Big Trees show little or no signs of extending their very limited range, hardly, even, of holding their present place, except under the most favorable conditions. Mr. Sudworth, dendrologist of the Division of Forestry, makes the following statements about the Calaveras Grove and Stanislaus Grove of Big Trees, which, it is important to notice, have been protected from both fire and grazing since the early fifties:

> Unlike the other species of its kind (Sequoia), the Coast Redwood, the Big Tree reproduces itself so slowly and with such uncertainty as to be practically at a standstill in these groves. A few seedlings took root in 1853–1855 in the Calaveras Grove, and are now 2 or 3 feet in diameter. There is no other evidence of increase in this grove, although the large trees are in a most thrifty state. The forest is not well watered, and the humus is too dry to encourage the reproduction of this species. Pines, firs, and cedars appear better able to propagate themselves on the same ground. On the borders of the grove the soil is so constantly dry and exposed to the trampling of grazing herds as to allow no reproduction outside of the forest. Moreover, the small, heavy seeds are carried to no considerable distance by the winds, as in the case of the pines, firs, and cedars. But if the reproduction of the Big Tree were the best conceivable, it would take several thousand years to replace the present groves after they were destroyed.
>
> The Stanislaus Grove is sparingly watered in parts by small perennial spring streams, and as a result shows a few small patches of Big Tree seedlings. (See Pl. V. fig. 1.) The constant soil moisture in the vicinity of these streams enables the seed to germinate, but only where big logs and other heavy débris exclude cattle and sheep. To lumber this tract would certainly soon effect the drying up of the small water supply, as it has already done elsewhere. The preservation of the race of Big Trees in this locality is unquestionably dependent on maintaining the present groves intact.

One region there is, however, where the Big Trees are reproducing themselves with some regularity. This is on the South Fork of the Kaweah River, and particularly on both branches of the Tule River, where there are young trees in abundance and of almost every age. But the discouraging aspect is that these groves are at present likely to be cut down, and should this happen, the reproduction noted will avail little in perpetuating the species, without the protecting influence of the mother forest.

BOTANICAL DESCRIPTION OF THE BIG TREE.

The following technical description of the Big Tree is taken from Prof. C. S. Sargent's "Silva of North America:"

The average height of Sequoia Wellingtonia is about 275 feet, and its trunk diameter near the ground 20 feet, although individuals from 300 to 320 feet tall, with trunks from 25 to 35 feet thick, are not rare. During four or five centuries the tapering stem is clothed with slender, crowded branches, which are erect above and horizontal near the middle of the tree, and below sweep toward the ground in graceful curves, thus forming a dense narrow strict pyramid. Gradually the lower branches disappear, and those at the top of the tree lose their aspiring habit; the trunk, which is much enlarged and buttressed at the base, and fluted with broad low rounded ridges, becomes naked for 100 or 150 feet; and the narrow, rounded crown of short horizontal branches loses its regularity, and gains picturesqueness from the eccentric development of some of the branches or the destruction of others. (See Pls. III, VII, and VIII.)

The bark of old trees is from 1 to 2 feet in thickness, and is divided into flat rounded lobes 4 or 5 feet wide, corresponding to the lobes of the trunk, and separating into loose-fibrous scales; it is light cinnamon-red, and the outer scales are slightly tinged with purple, which is more conspicuous on the much thinner bark of young trees. The leading branchlets are stout, pendulous, and furnished with numerous slender crowded much-divided rather closely appressed lateral branchlets, forming dense masses of spray; dark blue-green, like the leaves when they first appear, at the end of two or three years and after the disappearance of their leaves the branchlets are reddish-brown, more or less tinged with purple, and covered with thin close or slightly scaly bark.

The leaves are ovate, acuminate, or lanceolate, rounded and thickened on the lower surface, concave on the upper surface, and marked with bands of stomata on both sides of the obscure midribs, rigid and sharp pointed, decurrent below, spreading or closely appressed above the middle, and from one-eighth to one-quarter of an inch, or on stout leading shoots often one-half an inch in length; on young seedling plants they are linear-lanceolate, short-pointed, thin, spreading, pilose, often ciliate on the margins, and from one-half to three-fourths of an inch in length.

The flowers, which open late in the winter or in early spring, are produced in great profusion, especially the staminate, which often cover the whole tree, and dust the forest and the ground below it with their golden pollen. The staminate flower, which is usually terminal, varies from one-sixth to one-third of an inch in length, with ovate acute or acuminate denticulate connectives. and is subtended by broadly ovate scales rounded or acute at the apex, keeled on the back, concave on the inner surface, and slightly erose on the margins. The pistillate flower is about one-third of an inch long, with from 25 to 30, or rarely from 35 to 40 pale yellow scales, slightly keeled on the back, gradually narrowed into long slender points, and bearing from 3 to 7 ovules under each scale.

The fruit is ovate-oblong, from 2 to 3½ inches in length, from one-half inch to 2¼ inches in width, and dark red-brown; the scales are furnished on the upper side, near the base, with two or three large deciduous dark resin-glands, and are gradually thickened upward from the base to the apex, which is only slightly dilated, and is from three-fourths of an inch to 1¼ inches long, and from one-fourth to one-half of an inch wide, deeply pitted in the middle, which is often furnished with an elongated reflexed mucro, and frequently transversely ridged; at maturity they remain straight and rigid and open only slightly, the cone retaining its original form even when dry. From 3 to 7 seeds are produced under each scale; they are linear-lanceolate, compressed, from one-eighth to one-fourth inch in length, light brown, and surrounded by lateral united wings broader than the body of the seed, apiculate at the apex, and often unequal.

The Big Tree is the largest inhabitant of the American forests, and the most massive-stemmed although not the tallest tree in the world. It grows in an uninterrupted belt, chiefly associated with the Sugar Pine, the Douglas Fir, and the Incense Cedar, from the middle fork of the American River southward along the western flank of the California Sierras for a distance of about 260 miles to the head of Deer Creek, the northern limit of this belt being near the thirty-ninth and its southern just south of the thirty-sixth degree of north latitude, and its elevation from 5,000 to 8,400 feet above the level of the sea.

The wood of the Big Tree is very light, soft, not strong, brittle, and coarse-grained, but very durable in contact with the soil. It is bright clear red, turning darker on exposure, with thin nearly white sapwood, and contains thin dark-colored conspicuous bands of small summer-cells and numerous thin medullary rays. The specific gravity of the absolutely dry wood is 0.2882, a cubic foot weighing 17.96 pounds. Manufactured into lumber, it is used locally for fencing and in construction, and is made into shingles.

BOTANICAL NOMENCLATURE OF THE BIG TREE.

The selection of the proper scientific name for the Big Tree has been the subject of much discussion, and is a question concerning which there is still considerable disagreement among authorities. Since the tree first became known to botanists it has received the five following scientific names:

1. Wellingtonia gigantea Lindley. 1853.
2. Sequoia gigantea Decaisne. 1854.
3. Taxodium Washingtonianum Winslow. 1854.
4. Sequoia Wellingtonia Seeman. 1855.
5. Sequoia Washingtoniana (Winsl.) Sudworth. 1898.

For reasons founded on the fixed principles in botanical law, the first two names are permanently barred from use. The present dissension among authorities centers on which of the last two names should be applied to the Big Tree. It is believed, however, that Sequoia Washingtoniana is the correct name for this tree, as shown in Bulletin 17, Division of Forestry, United States Department of Agriculture.

INTRODUCTION OF THE BIG TREE INTO CULTIVATION.

William Lobb visited the Calaveras Grove in 1854 and succeeded in introducing this Sequoia into English gardens. It is now one of the most universally cultivated coniferous trees in all the countries of central and southern Europe, but, while it has grown rapidly, it is already beginning to show that the existing climates of Europe do not suit it, and that this glory of the Sierra forests need fear no rival among the emigrants of its race. It has also been occasionally cultivated in the eastern United States, where it does not flourish, although it has occasionally survived in a few sheltered or particularly favorable situations.[1]

The best examples of success in cultivating this tree in the East are to be seen in the nursery of Messrs. Elwanger and Barry, Rochester, N. Y., where there are two trees about 35 feet high.

OWNERSHIP OF BIG TREE LANDS.

The ownership of the Big-Tree timber lands of California is divided among the State, the Federal Government, and private individuals.

State Holdings.

California owns but one tract, which includes the Mariposa Grove. This was ceded to California by the United States in 1865, in an act known as the "Yosemite and Big Tree Grant," by the terms of which the State received the Yosemite Valley proper and the Mariposa Grove, to hold and protect as State parks. The extent of the Mariposa grant is 2 square miles, or, roughly, about 4 per cent of the total area on which the Big Tree grows.

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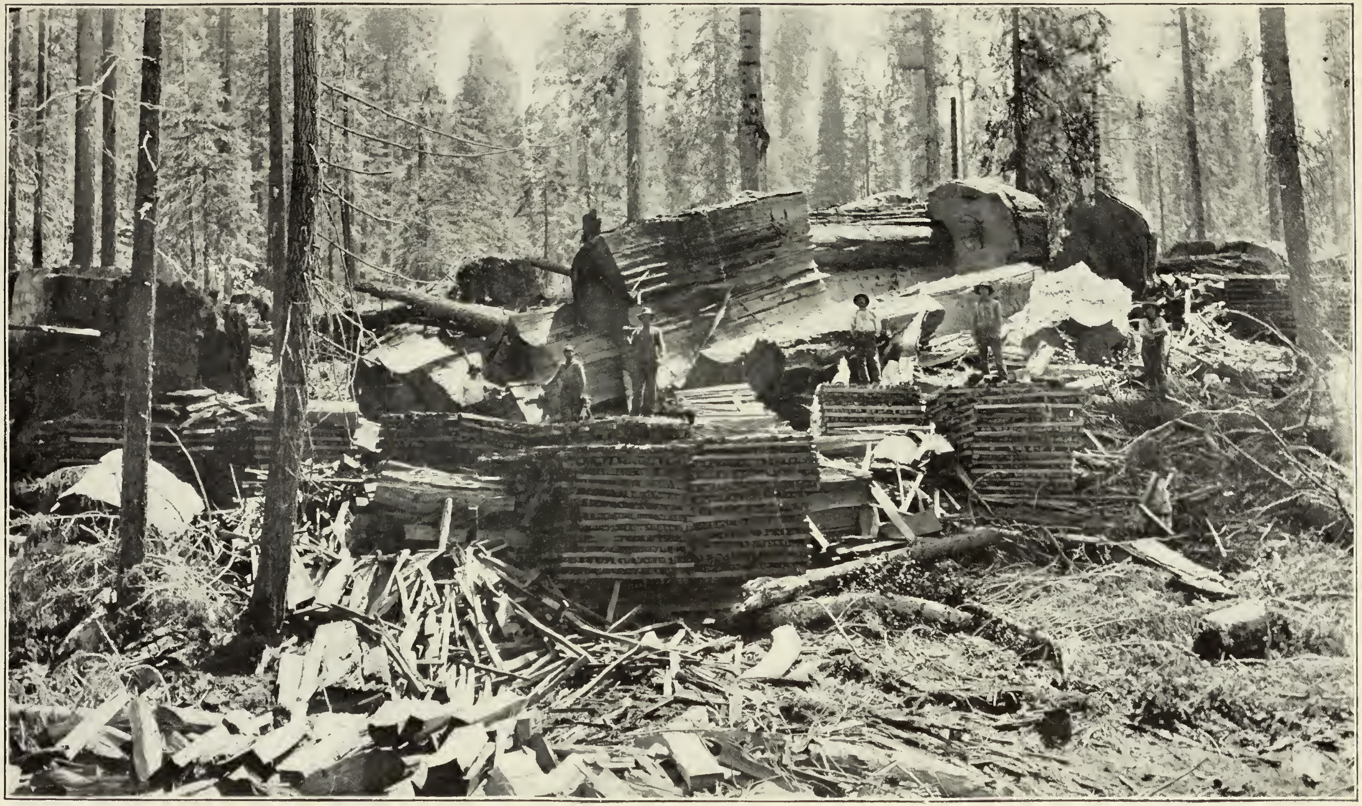
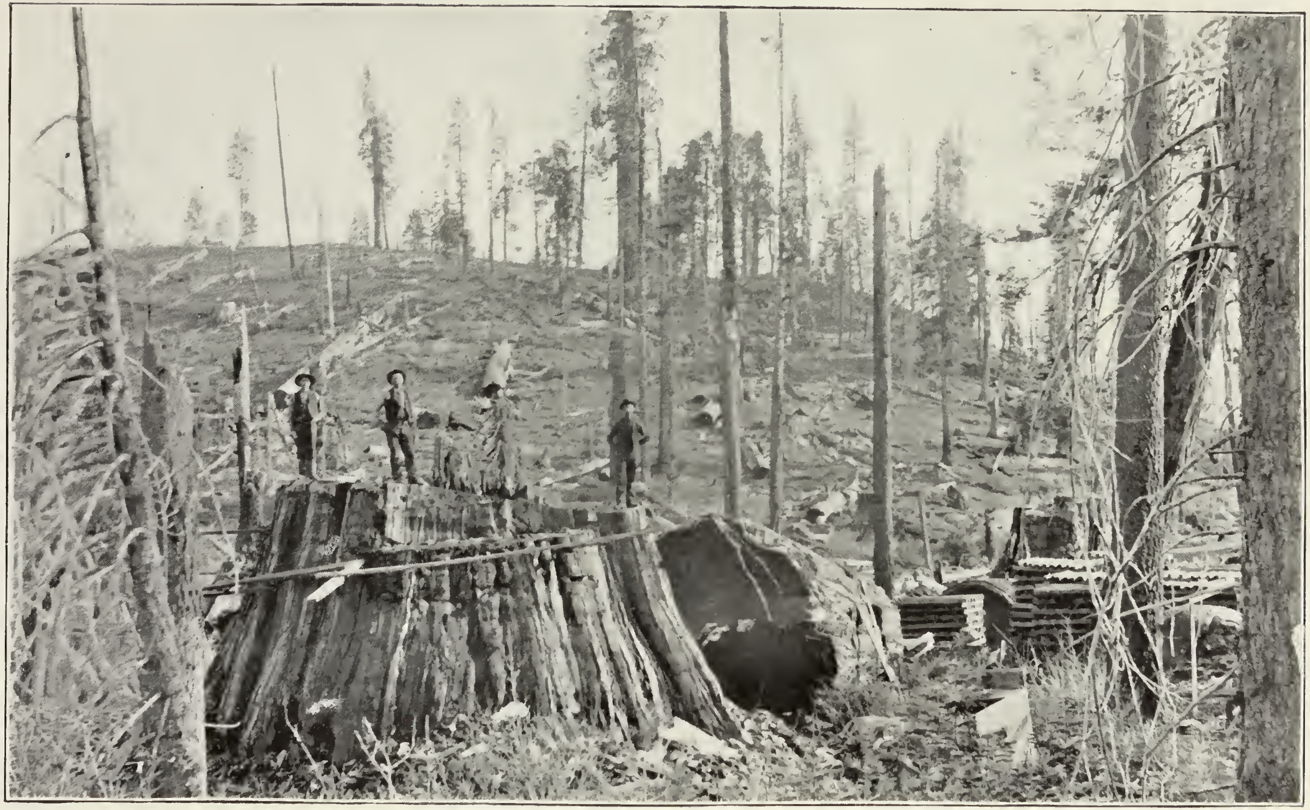
[1] Prof. C. S. Sargent, in "Silva of North America."

PLATE IX.

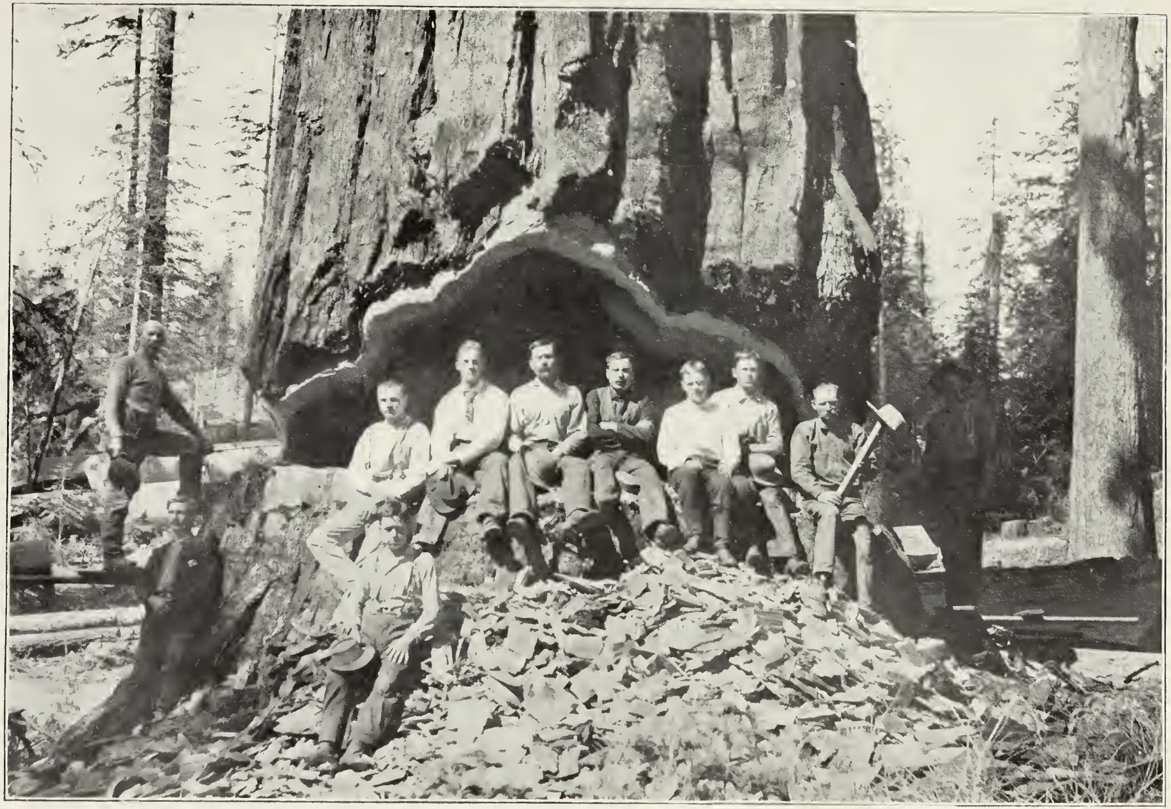


LUMBERING BIG TREES ON KINGS RIVER: MAKING GRAPEVINE STAKES; SHOWS THE EFFECT OF BLASTING WITH POWDER,

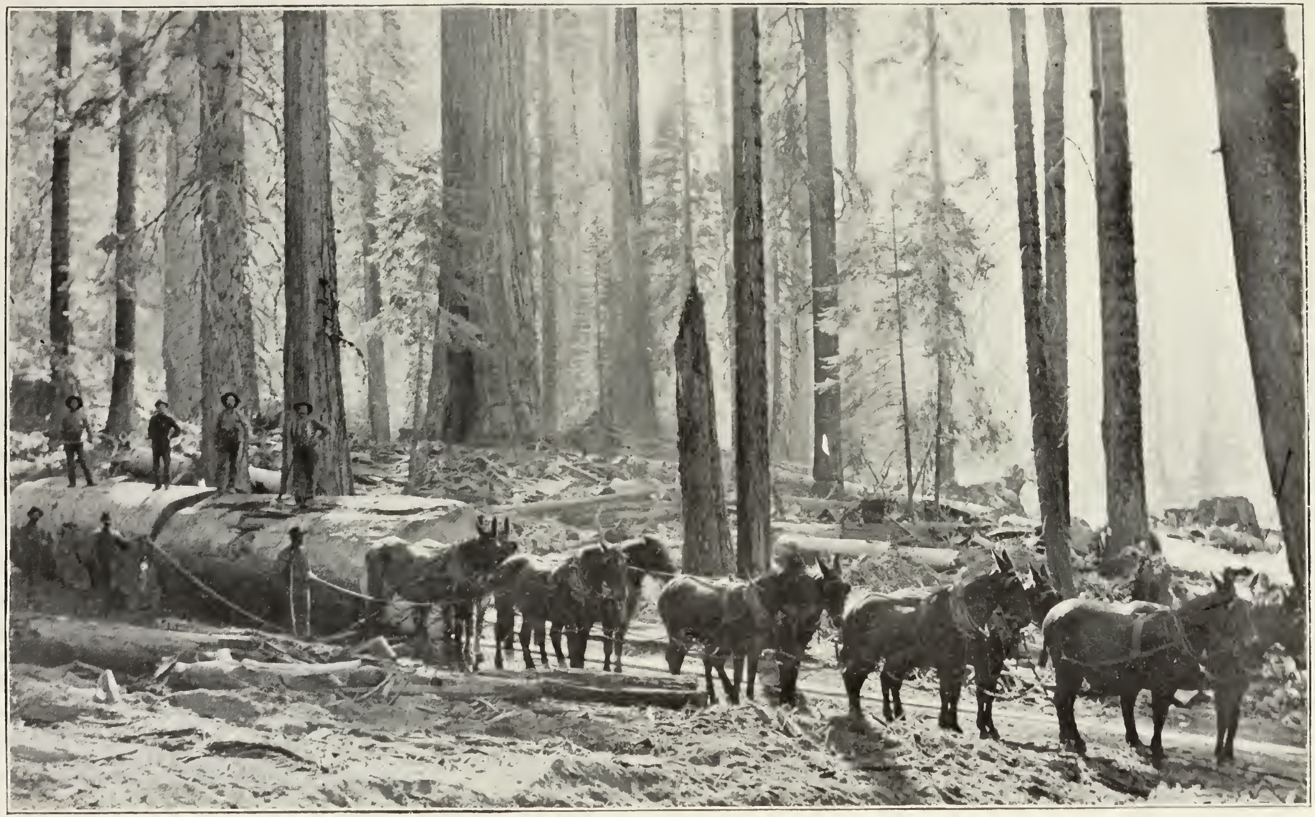


BIG TREE TIMBER CUT FOR GRAPEVINE STAKES, SHOWING ENORMOUS WASTE IN LUMBERING AND DESOLATE APPEARANCE OF SUCH DENUDED LANDS.

PLATE XI.

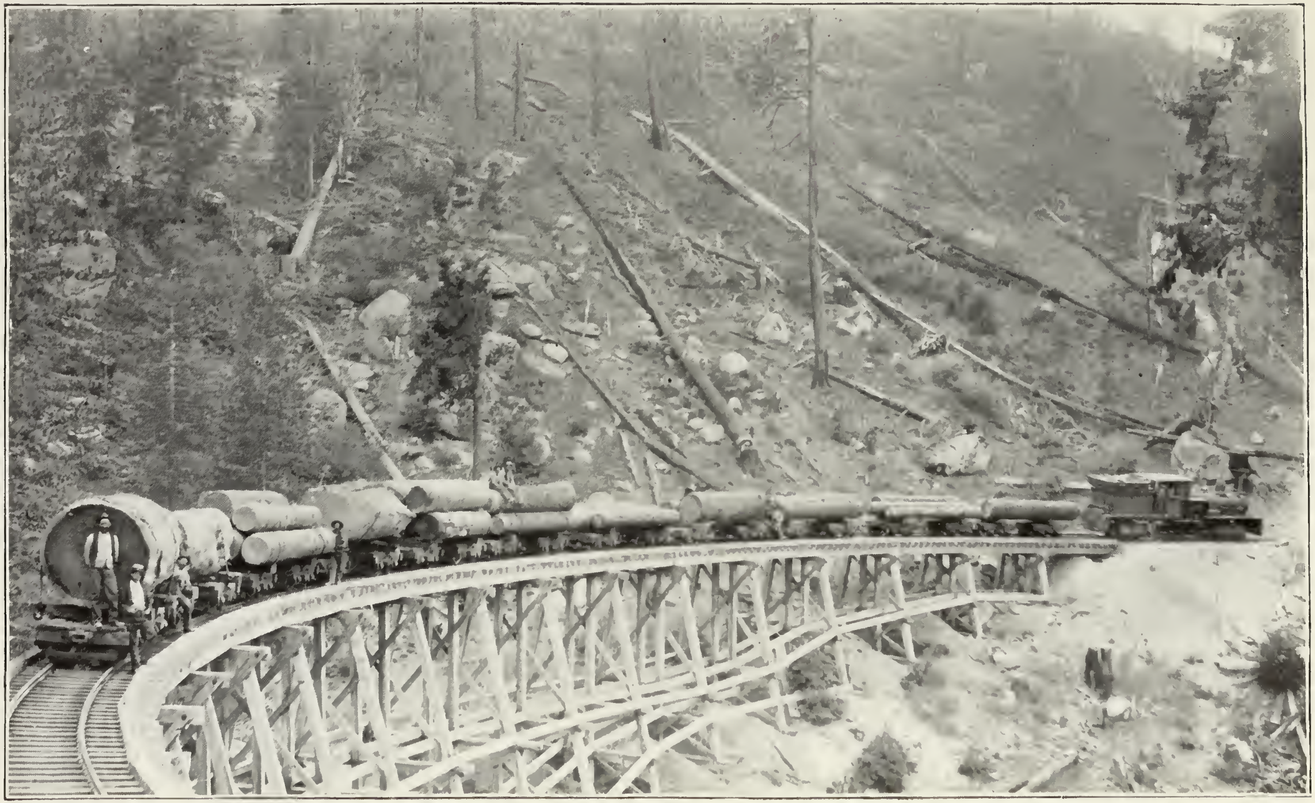


FELLING A BIG TREE WITH AXES.



HAULING OUT BIG TREE SAW LOGS ON A LOG SLIDE.

PLATE XIII.



Logging Railroad in a Big Tree Forest, showing Train carrying Big Tree and Yellow Pine Logs.

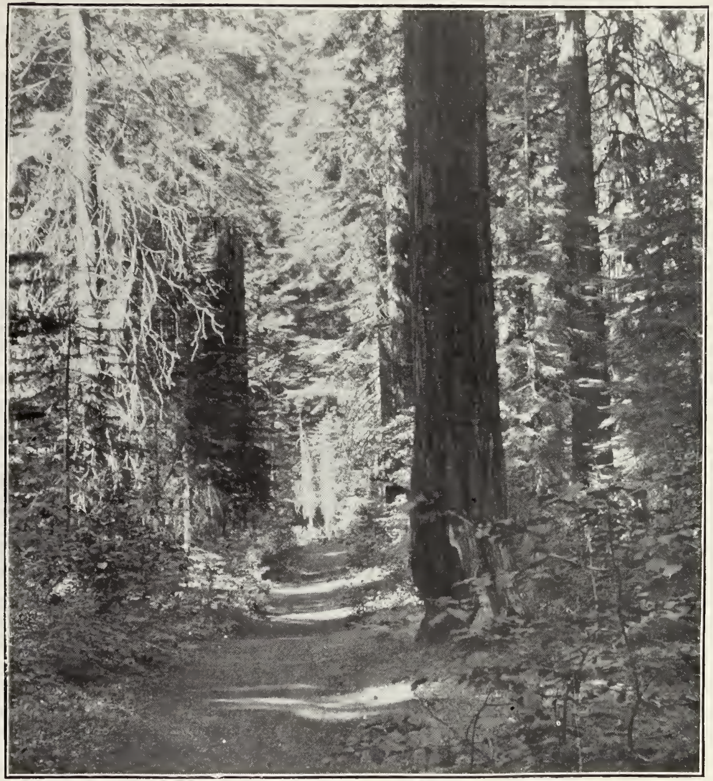


FIG. 1.—CALAVERAS BIG TREE GROVE, SHOWING TRAIL IN INTERIOR OF FOREST, WITH WELL-PRESERVED, DENSE UNDERGROWTH OF TREE SEEDLINGS, SHRUBS, AND HERBACEOUS PLANTS; SHOWS A BIG TREE BADLY BURNT AT BASE ON THE RIGHT.

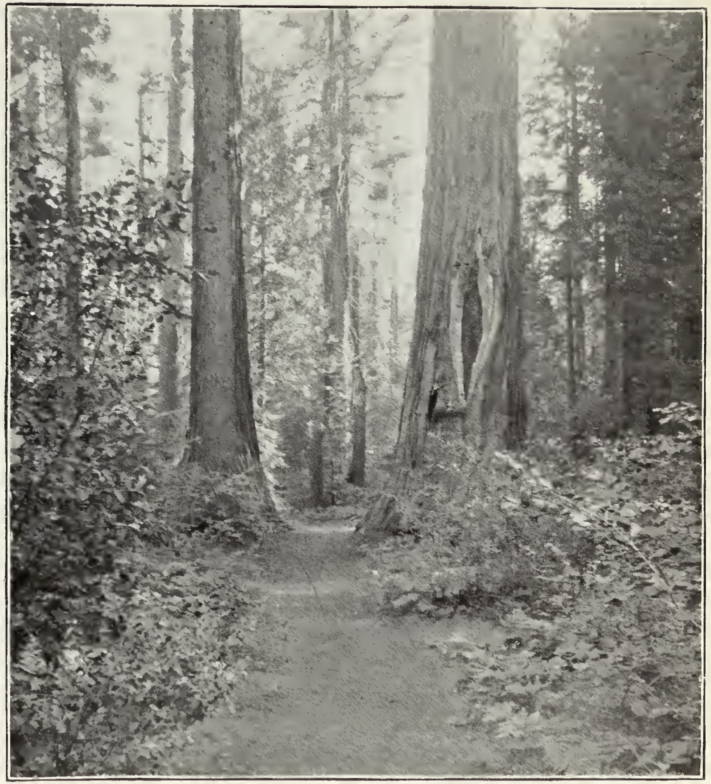


FIG. 2.—CALAVERAS BIG TREE GROVE, SHOWING DENSE UNDERGROWTH IN INTERIOR OF FOREST, WITH FIRE-SCARRED BIG TREE ON RIGHT AND SUGAR PINE 8 FEET IN DIAMETER ON LEFT.

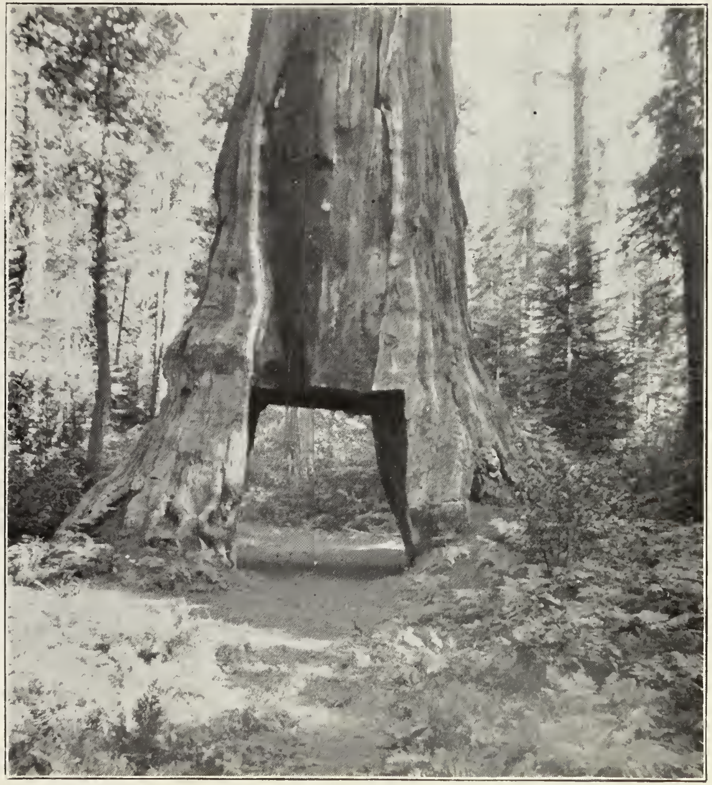


FIG. 1.—CALAVERAS BIG TREE GROVE, SHOWING DENSE, WELL-PRESERVED UNDERGROWTH, WITH "THE PIONEER" NEAR CENTER OF GROVE, 32 FEET IN DIAMETER NEAR BASE.

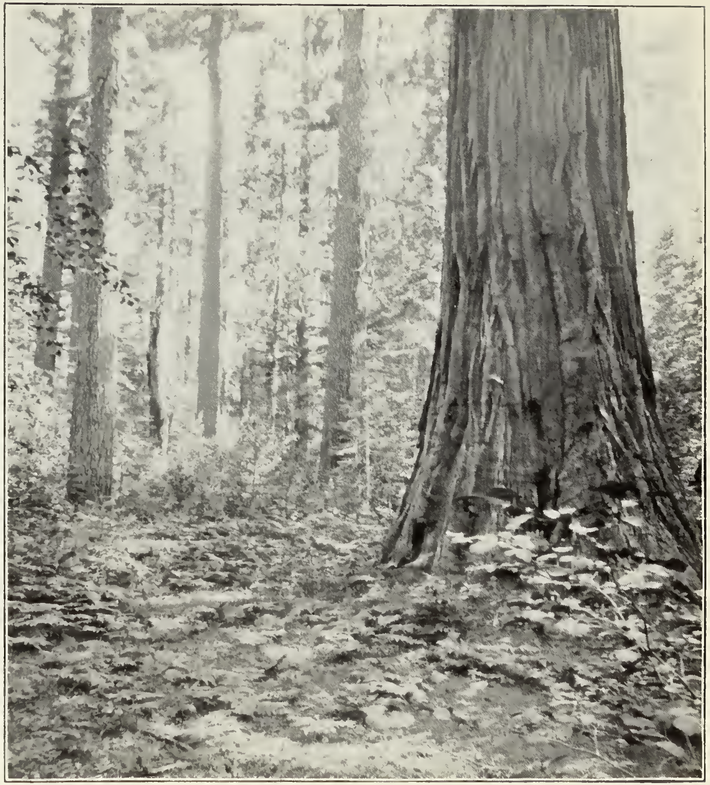


FIG. 2.—CALAVERAS BIG TREE GROVE, SHOWING DENSE UNDERGROWTH OF TREE SEEDLINGS, SHRUBS, AND HERBACEOUS PLANTS IN INTERIOR OF FOREST, WITH BIG TREE 28 FEET IN DIAMETER ON THE RIGHT AND LARGEST SUGAR PINES ON THE LEFT BEYOND.

9

			4	5	6
7	8	9	10	11	12
13	14	15	16	17	18

THE FOLLOWING FOLDING PLATE
HAS BEEN FILMED IN 18 SECTIONS
IN THE SEQUENCE SHOWN

MAP SHOWING GENERAL LOCATION OF
BIG TREE GROVES, CALIFORNIA

9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24
25	26	27	28n	29	30	31	32

THE FOLLOWING FOLDING PLATE
HAS BEEN FILMED IN 32 SECTIONS
IN THE SEQUENCE SHOWN

MAP SHOWING LOCATION OF BIG TREE GROVES
IN FRESNO AND TULARE COUNTIES, CALIFORNIA

Map sh

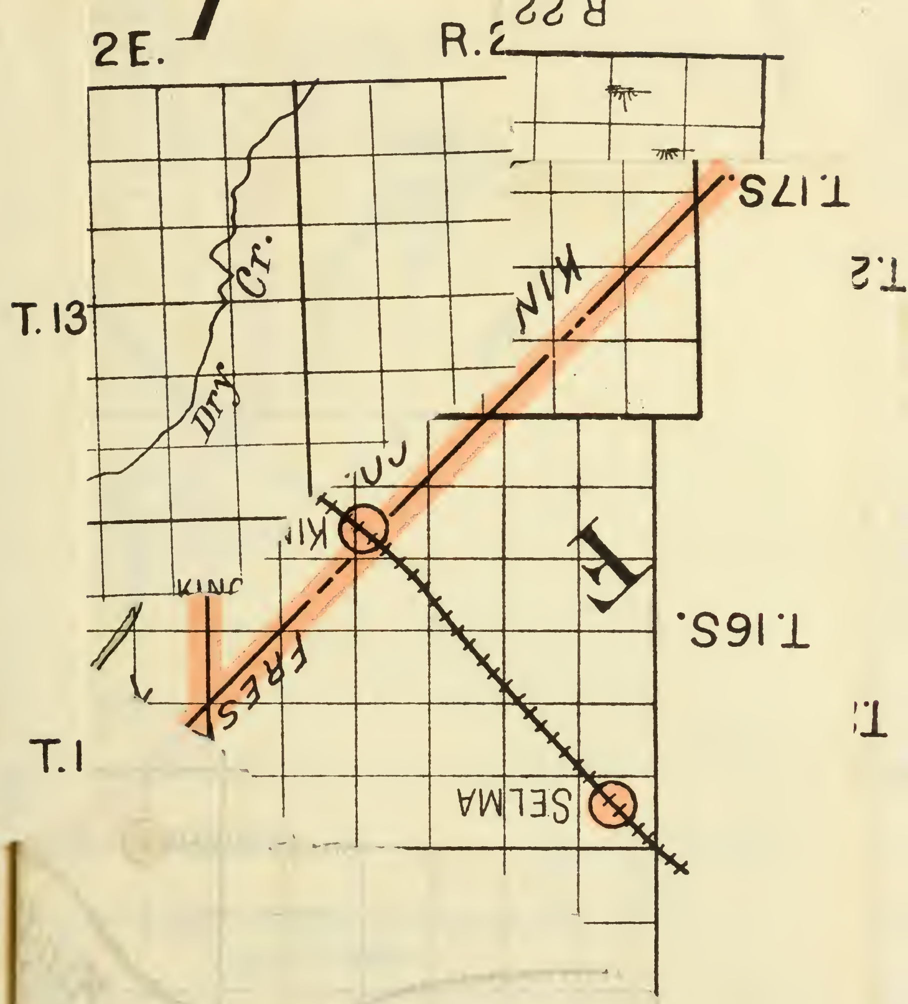
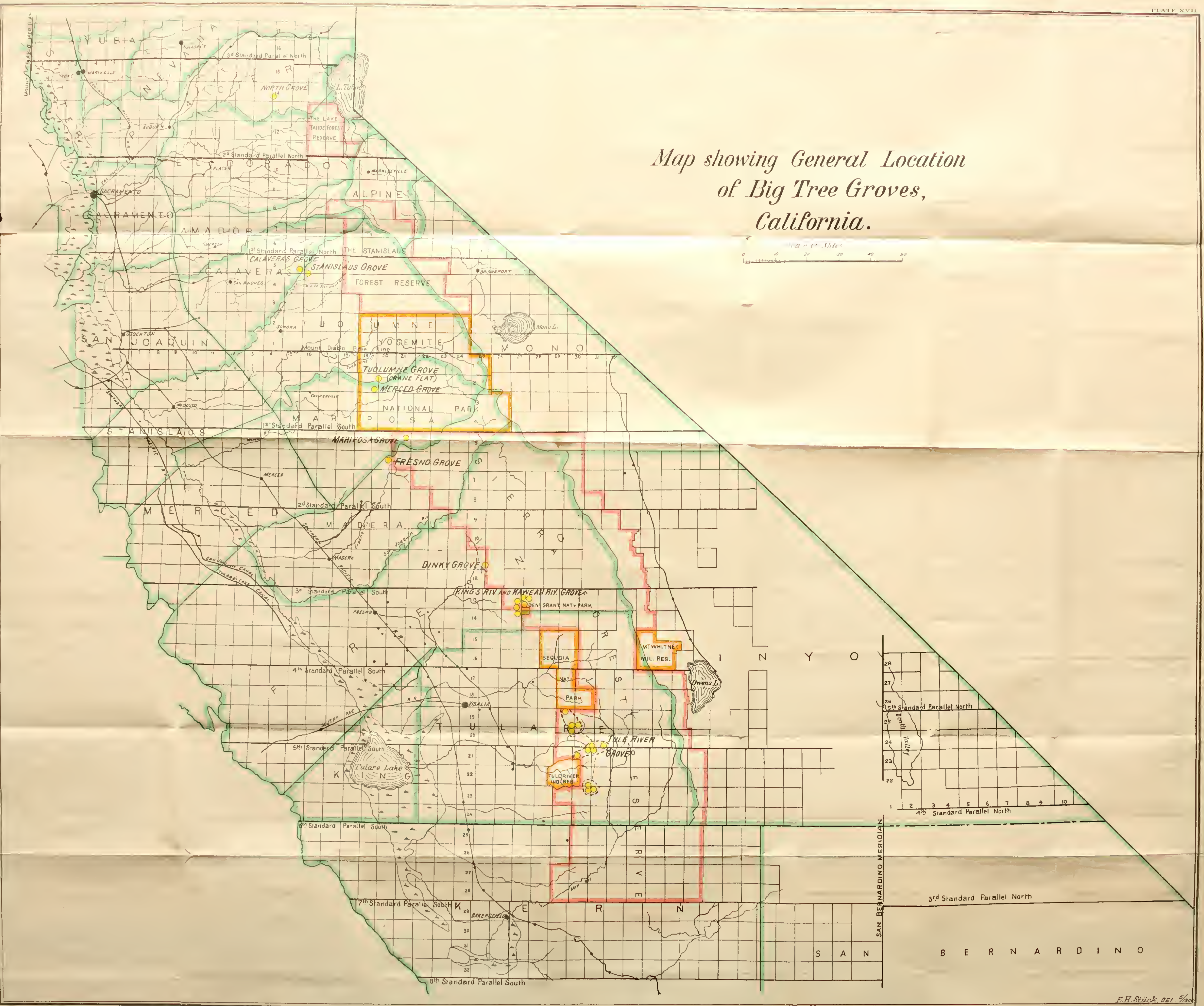


PLATE XVII.

E.H. Stück, DEL. 5/1900



Map showing General Location of Big Tree Groves, California.

Government Holdings.

The United States owns and in part controls two considerable areas, comprised within the Sequoia and General Grant National parks. These are very difficult to define. According to the acts of Congress which established them October 1, 1890, they amount, respectively, to 161,280 and 2,560 acres. But it is well known that in the first at least, the Big Trees stand largely in one group on the Marble Fork of the Kaweah River, with only very scattering neighbors of their own kind; and a like distinction prevails in the General Grant National Park grove. Furthermore, along the west and south boundaries of the Sequoia National Park, there are seven valid private holdings, amounting to 1,012.87 acres, and an equally good claim of 160 acres in the General Grant National Park. In the first, also, there is a sawmill operating at the edge of the main clump of Big Tree timber, which is again true of the second grove. Consequently, as it is not possible to assert what proportion of these parks contain Big Trees, or just what the private tracts comprise, it is equally impossible to state the extent of the Government holdings in Big Tree timber. It can only be said that they are considerable, but imperfectly defined and poorly protected.

Private Holdings.

These include by far the greater part of the Big Trees, and, except some groves in Tulare County, they are held by sawmill or logging companies. The large tract on Kings River is almost entirely so owned; and the famous Calaveras or "Mammoth" Grove, which has been carefully preserved since the early fifties, is now owned by a man who is said to represent a lumber syndicate. The Big Trees of Fresno County are controlled by the Sanger Lumber Company. The rest of the southern tracts, in and about and to the south of the Sequoia National Park, are divided chiefly into small areas among private owners.

Location of Big Tree Lands.

The following list, and accompanying large map (Pl. XVI), compiled from notes and a sketch map prepared by Prof. William R. Dudley,[1] give the location, amount, and ownership of Big Tree lands in Fresno and Tulare counties. The data compiled is based upon the Tulare County records of 1899–1900, and upon Professor Dudley's personal examination of the areas in question. The accompanying small map (Pl. XVII) gives the general location of all the Big Tree groves.

Fresno County.

TOWNSHIP 13 SOUTH, RANGE 27 EAST.

No. of section.	No. on map.	Size of claim.	Name of owner.	Residence.
		Acres.		
1	1	*a* 40	Fannie Wilcox	
2	1	*a* 80	do	
2	2	*a* 40	G. T. Nightbert and J. M. Fox	
2	3	120	Sanger Lumber Co.	Sanger, Cal.
11	4	40	Ellen S. Eastwood	
11	3	440	Sanger Lumber Co	Do.
12	3	480	do	Do.
12	5	160	J. W. Blade	
13	3	280	Sanger Lumber Co	Do.

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[1] A collaborator in the Division in Forestry, United States Department of Agriculture.

Fresno County—Continued.

TOWNSHIP 13 SOUTH, RANGE 27 EAST—Continued.

No. of section.	No. on map.	Size of claim.	Name of owner.	Residence.
		Acres.		
13	6	340	S. Sweet & Co	Visalia, Cal.
14	3	40	Sanger Lumber Co	Sanger, Cal.
15	3	40	do	Do.
16	3	320	do	Do.
16	7	320	E. D. Sullivan	
21	3	320	Sanger Lumber Co	Do.
22	3	480	do	Do.
22	8	160	M. W. Kirkland and D. McRea	San Francisco, Cal.
23	3	440	Sanger Lumber Co	Sanger, Cal.
24	3	40	do	Do.
24	9	160	W. N. Switzer	
25	3	640	Sanger Lumber Co	Do.
26	3	640	do	Do.
27	3	640	do	Do.
28	3	640	do	Do.
29	3	560	do	Do.
29	10	80	James L. Young	Lindsay, Cal.
30	10	160	do	Do.
31	11	80	John C. Dunlap	Dunlap, Cal.
32	11	160	do	Do.
32	3	40	Sanger Lumber Co	Sanger, Cal.
33	3	320	do	Do.
34	3	440	do	Do.
35	3	640	do	Do.
36	3	640	do	Do.

TOWNSHIP 13 SOUTH, RANGE 28 EAST.

No. of section.	No. on map.	Size of claim.	Name of owner.	Residence.
3	3	80	Sanger Lumber Co	Sanger, Cal.
4	3	440	do	Do.
5	3	440	do	Do.
5	12	160	J. A. Schapp	
7	3	640	Sanger Lumber Co	Do.
8	3	640	do	Do.
9	3	640	do	Do.
10	3	640	do	Do.
13	3	320	do	Do.
13	6	160	S. Sweet & Co	Visalia, Cal.
13	13	160	E. Jacob	Do.
14	U. S.	160	United States	
14	3	480	Sanger Lumber Co	Sanger, Cal.
15	3	440	do	Do.
15	14	120	August Bergin	
16	3	640	Sanger Lumber Co	Do.
17	3	640	do	Do.
18	3	640	do	Do.
19	U. S.	640	United States	
20	U. S.	160	do	
20	3	480	Sanger Lumber Co	Do.
21	3	40	do	Do.
21	U. S.	600	United States	
22	15	40	Mrs. Ella Byrnes	Visalia, Cal.
22	16	160	S. Mitchell	
22	3	280	Sanger Lumber Co	Sanger, Cal.
22	U. S.	160	United States	
23	3	480	Sanger Lumber Co	Do.
23	16	160	S. Mitchell	
24	3	480	Sanger Lumber Co	Do.
24	17	160	Fox and Sweetland	Lemoore, Cal.
25	3	480	Sanger Lumber Co	Sanger, Cal.
26	3	640	do	Do.
27	3	480	do	Do.
27	U. S.	160	United States	
28	U. S.	160	do	
28	18	200	John W. Parker	Dinuba, Cal.
28	3	280	Sanger Lumber Co	Sanger, Cal.
29	3	640	do	Do.
30	3	640	do	Do.
31	3	160	do	Do.
33	U. S.	640	United States	
34	19	160	Louis Seligman	Dinuba, Cal.
34	3	320	Sanger Lumber Co	Sanger, Cal.
35	20	160	W. E. Weld	Visalia, Cal.
35	3	480	Sanger Lumber Co	Sanger, Cal.
36	3	640	do	Do.

a Sold for taxes, 1899.

Fresno County—Continued.

TOWNSHIP 13 SOUTH, RANGE 29 EAST.

No. of section.	No. on map.	Size of claim.	Name of owner.	Residence.
		Acres.		
7	3	320	Sanger Lumber Co	Sanger, Cal.
15	3	160	.....do	Do.
16	3	640	.....do	Do.
17	3	320	.....do	Do.
17	21	160	S. W. Finker	Alma, Mich.
17	U. S.	80	United States	
18	U. S.	320	.....do	
18	3	320	Sanger Lumber Co	Sanger, Cal.
19	3	320	.....do	Do.
21	3	320	.....do	Do.
21	22	40	D. K. Zumwalt	Visalia, Cal.
22	3	160	Sanger Lumber Co	Sanger, Cal.
26	3	120	.....do	Do.
27	3	240	.....do	Do.
27	16	120	S. Mitchell	
27	21	80	S. W. Finker	Alma, Mich.
28	21	80	.....do	Do.
28	23	40	Richard Hedinger	Fresno, Cal.
28	3	120	Sanger Lumber Co	Do.
29	3	40	.....do	Do.
30	3	240	.....do	Do.
31	3	160	.....do	Do.
32	3	40	.....do	Do.
34	3	160	.....do	Sanger, Cal.
35	3	160	.....do	Do.
36	3	160	.....do	Do.

Tulare County.

TOWNSHIP 14 SOUTH, RANGE 27 EAST.

No. of section.	No. on map.	Size of claim.	Name of owner.	Residence.
		Acres.		
1	3	640	Sanger Lumber Co	Sanger, Cal.
2	3	640	.....do	Do.
3	3	160	.....do	Do.
11	24	120	Granville Millsap	Sold for taxes, 1899.
12	24	40	.....do	Do.
12	25	80	Frankeman & Son	Sanger, Cal.
12	3	200	Sanger Lumber Co	Do.
12	26	160	Adaline Comstock	
13	26	400	.....do	
13	28	80	E. W. Jardine	
14	26	40	Adaline Comstock	
24	29	200	J. R. Rodgers	

TOWNSHIP 14 SOUTH, RANGE 28 EAST.

1	30	80	S. Plunkett	Visalia, Cal.
1	31	160	L. M. Atwill and Benj. Hicks	Do.
1	32	80	L. O. Cutler	Do.
1	33	40	A. J. Weston	Do.
2	33	120	.....do	Do.
2	34	80	Otto Sweet	Do.
2	3	80	Sanger Lumber Co	Sanger, Cal.
3	3	80	.....do	Do.
5	35	160	E. O. Miller	Visalia, Cal.
7	3	80	Sanger Lumber Co	Sanger, Cal.
8	36	40	Meyer E. Iseman	Visalia, Cal.
10	37	80	Peter McArthur	Detroit, Mich.
11	33	120	A. J. Weston	Visalia, Cal.
12	33	200	.....do	Do.
13	37	80	Peter McArthur	Detroit, Mich.
14	37	240	.....do	Do.
14	38	200	George D. Bliss	San Francisco, Cal.
15	38	280	.....do	Do.
15	39	40	P. Dougherty	Visalia, Cal.
15	37	120	Peter McArthur	Detroit, Mich,
15	40	120	Horace Whitaker	Orosi, Cal.
15	41	40	J. S. Boyd or —. —. Howard	Reedley, Cal.

Tulare County—Continued.

TOWNSHIP 14 SOUTH, RANGE 28 EAST—Continued.

No. of section.	No. on map.	Size of claim.	Name of owner.	Residence.
		Acres.		
15	42	40	R. Z. Dudley	Visalia, Cal.
16	40	160	Horace Whitaker	Orosi, Cal.
16	43	160	Tax deed, State of California	
16	44	320	William Coburn	Springville, Cal.
18	13	80	E. Jacob	Visalia, Cal.
19	13	160	.....do	Do.
21	40	80	Horace Whitaker	Orosi, Cal.
21	45	120	Mary I. Evans	
21	46	40	T. Rooney	
21	47	80	J. W. Guinn and E. L. Huffman	Visalia, Cal.
21	48	40	Estelle Ruggles	
22	40	40	Horace Whitaker	Orosi, Cal.
22	47	40	J. W. Guinn and E. L. Huffman	Visalia, Cal.
22	42	40	R. Z. Dudley	Do.
22	37	400	Peter McArthur	Detroit, Mich.
22	35	120	E. O. Miller	Visalia, Cal.
23	38	440	George D. Bliss	San Francisco, Cal.
23	37	40	Peter McArthur	Detroit, Mich.
23	49	80	Wm. Z. Garton	
24	37	400	Peter McArthur	Do.
24	43	80	Tax deed, State of California	
25	50	160	Claus Spreckels	San Francisco, Cal.
25	35	160	E. O. Miller	Visalia, Cal.
26	37	160	Peter McArthur	Detroit, Mich.
26	51	160	Estate of Thos. Wootton	Fresno, Cal.
26	52	160	C. W. Clark	Sacramento, Cal.
27	35	40	E. O. Miller	Visalia, Cal.
27	53	120	J. Goldman	Tulare, Cal.
27	54	80	A. R. Orr, one-half, and R. Chatten, one-half.	Visalia, Cal.
27	42	40	R. Z. Dudley	Do.
27	55	40	R. Chatten	Do.
27	56	40	J. O. Osborn	Exeter, Cal.
28	53	280	J. Goldman	Tulare, Cal.
28	57	80	A. Lewis	
33	58	160	A. D. Halstead	Visalia, Cal.
33	37	320	Peter McArthur	Detroit, Mich.
34	37	40	.....do	Do.
35	52	160	C. W. Clark	Sacramento, Cal.
35	35	160	E. O. Miller	Visalia, Cal.
36	59	40	Floyd B. Wilson	

TOWNSHIP 15 SOUTH, RANGE 28 EAST.

No. of section.	No. on map.	Size of claim.	Name of owner.	Residence.
3	37	120	Peter McArthur	Detroit, Mich.
4	37	480	.....do	Do.
4	60	160	James Halstead	Visalia, Cal.
5	37	80	Peter McArthur	Detroit, Mich.

TOWNSHIP 15 SOUTH, RANGE 30 EAST.

No. of section.	No. on map.	Size of claim.	Name of owner.	Residence.
28	61	40	J. F. Jordan	Visalia, Cal.
29	62	120	N. W. Tharp	Do.
30	61	40	J. F. Jordan	Do.
33	61	80	.....do	Do.

TOWNSHIP 16 SOUTH, RANGE 30 EAST.

No. of section.	No. on map.	Size of claim.	Name of owner.	Residence.
5	61 62 63	280	J. F. Jordan, one-half N. W. Tharp, one-quarter H. D. Tharp, one-quarter	Visalia, Cal.
6	61 62 63	160	H. D. Tharp	Do.
7	64	40	Gus. Weinman	

TOWNSHIP 16 SOUTH, RANGE 31 EAST.

No. of section.	No. on map.	Size of claim.	Name of owner.	Residence.
20	65	40	J. L. Hamilton	Exeter, Cal.
21	65	40	.....do	Do.

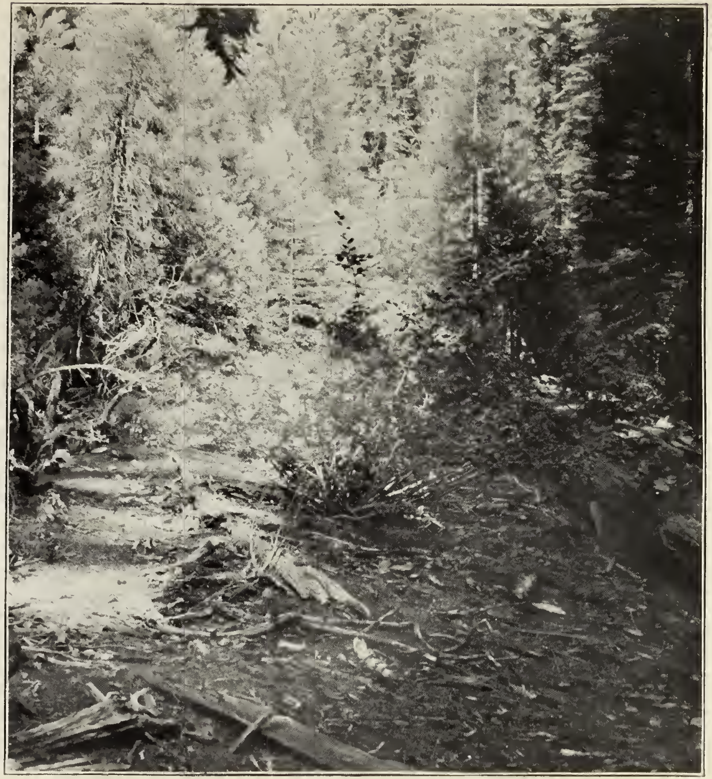


FIG. 1.—STANISLAUS BIG TREE GROVE, SHOWING INTERIOR OF FOREST WITH DENSE STAND OF SEEDLING AND SAPLING BIG TREES, WITH GRAZED AND TRAMPLED SPOT IN FOREGROUND.

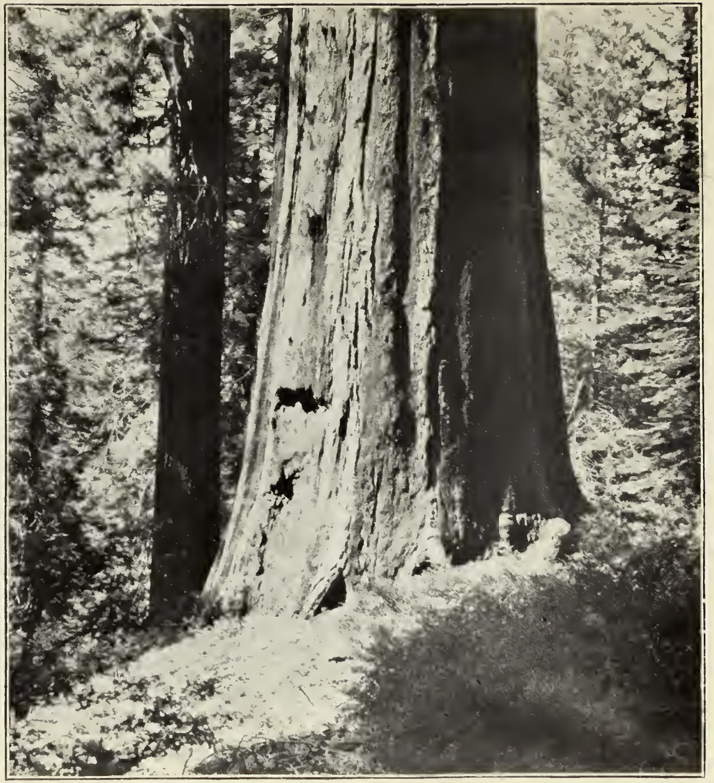
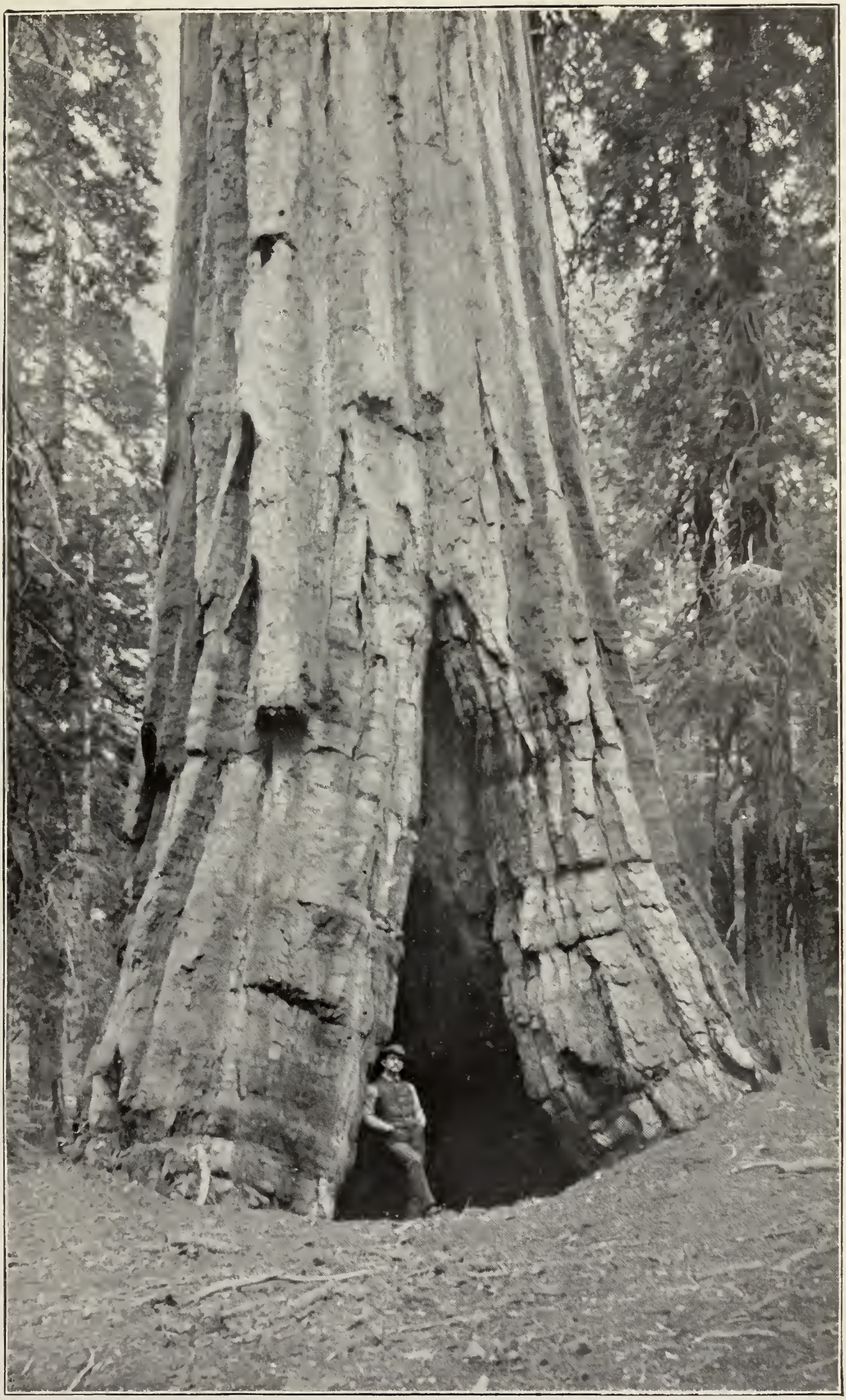
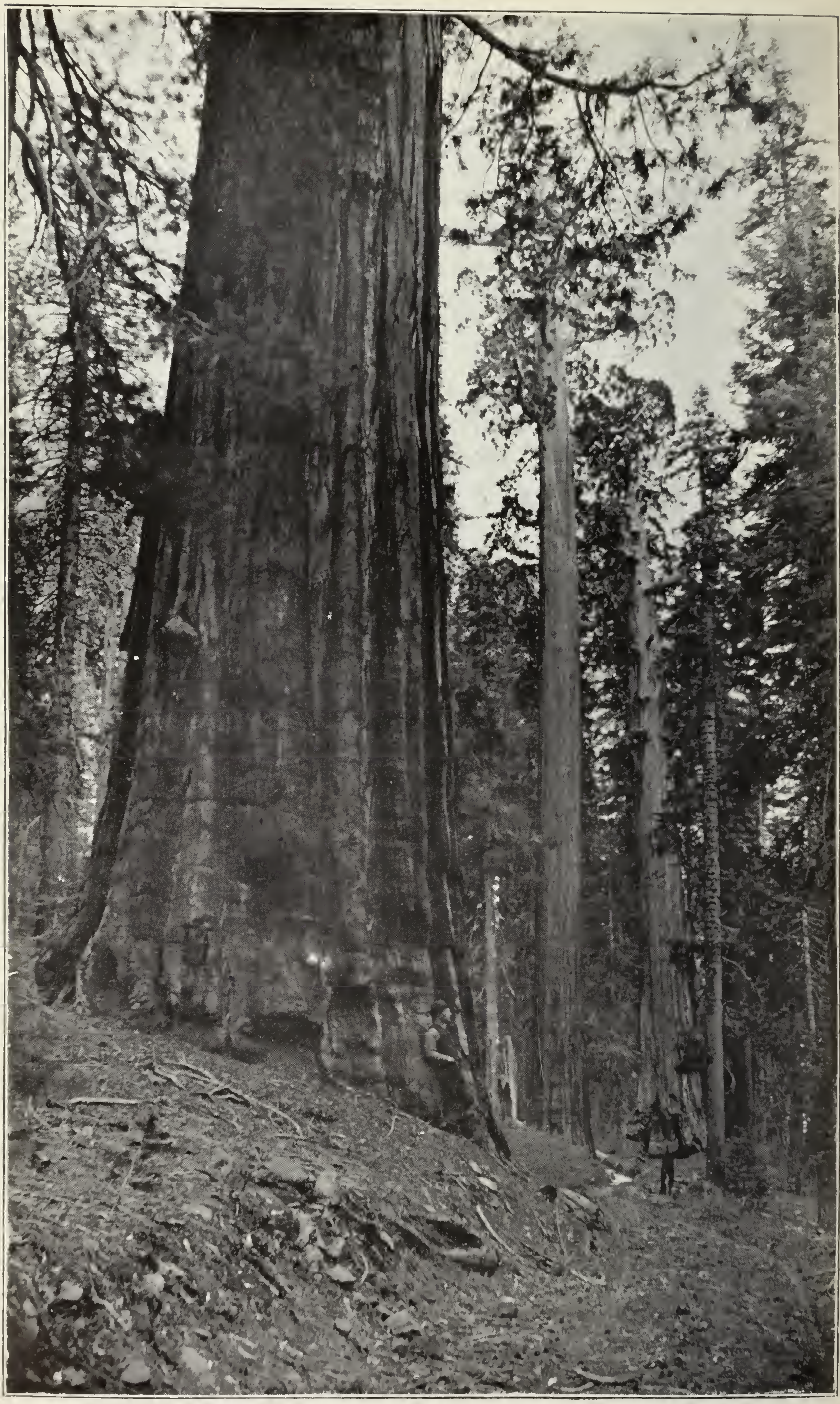


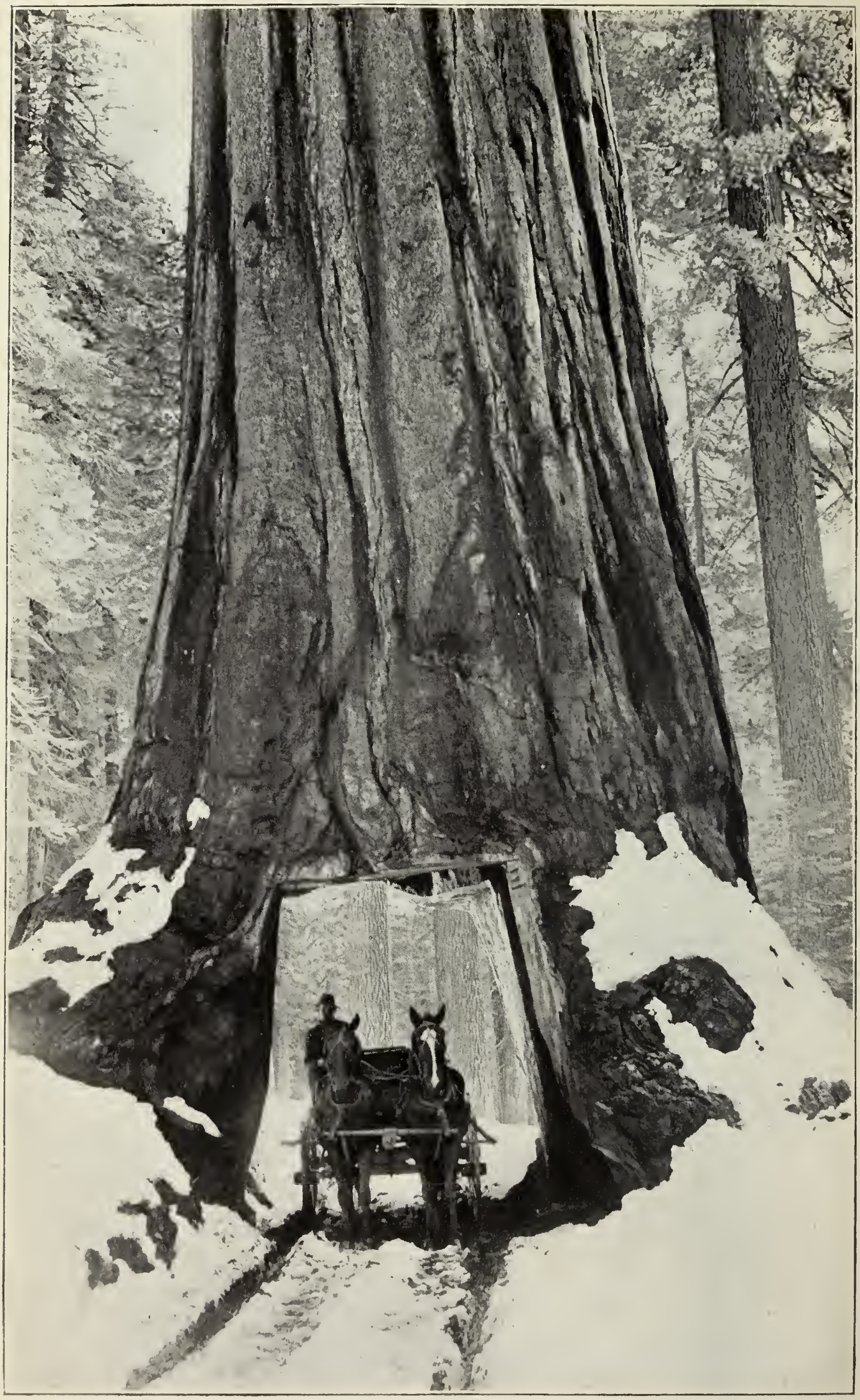
FIG. 2.—THE STANISLAUS BIG TREE GROVE: INTERIOR OF FOREST, SHOWING BIG TREE, 22 FEET IN DIAMETER, AND GENERAL APPEARANCE OF FOREST.



SMITH'S CABIN, A GIANT BIG TREE IN THE STANISLAUS GROVE, THE HOLLOW BASE HAVING BEEN USED IN EARLY YEARS AS A HUNTER'S CABIN.



Big Trees in the Mariposa Grove.



THE BIG TREE "WAWONA" IN THE MARIPOSA GROVE, SHOWING THE RELATIVE SIZE OF OTHER CONIFERS COMPARED WITH BIG TREES.

Tulare County—Continued.

TOWNSHIP 17 SOUTH, RANGE 29 EAST.

No. of section.	No. on map.	Size of claim. Acres.	Name of owner.	Residence.
23	66	80	Ira Chrisman	Visalia, Cal.
25	67	40	Wm T. Bell	
26	67	80	.....do	
26	68	40	Mary E. Southworth	
26	69	40	A. Hammer	Do.
26	70	160	James Fisher	Do.
26	71	160	C. F. Bahwell	Threerivers, Cal.
26	72	120	Lon Lewis	Visalia, Cal.
27	73	240	L. M. Howell	Do.
35	67	80	Wm. T. Bell	
35	35	160	E. O. Miller	Do.
36	72	320	Lon Lewis	Do.

TOWNSHIP 17 SOUTH, RANGE 30 EAST.

10	75	80	James McFadzean	Threerivers, Cal.
11	75	80	.....do	Do.
11	76 77 78 79	40	J. H. Moore, one-fourth W. F. Dean, one-fourth Maria Luce, one-fourth J. D. Mollinex, one-fourth	Do.
11	80	80	Mary M. Atwill	Visalia, Cal.
12	80	80	.....do	Do.

TOWNSHIP 17 SOUTH, RANGE 31 EAST.

18	81	200	John Cutler	Visalia, Cal.

TOWNSHIP 19 SOUTH, RANGE 30 EAST.

2	82	240	J. M. Canty	Grayson, Cal.
2	83	40	N. P. Dillon	Milo, Cal.
3	82	280	J. M. Canty	Grayson, Cal.
3	83	360	N. P. Dillon	Milo, Cal.
4	83	120	.....do	Do.
9	83	40	.....do	Do.
10	83	160	.....do	Do.
10	84	80	J. F. Lindsay	Said to be same interest as N. P. Dillon.
11	83	40	N. P. Dillon	Milo, Cal.
23	85 86	80	F. J. Nash, one-half, and Alice A. Nash, one-half.	Salem, Mass.
24	87	80	J. J. Doyle	Porterville, Cal.
25	88	320	Louisa Greenwald	San Francisco, Cal.
25	89	80	Enterprise Lumber Co	Springville, Cal.
25	90	80	Jesse Hoskins	Lindsay, Cal.
25	91 89	120	George E. Guerne in Enterprise Lumber Co	Springville, Cal.
26	88	160	Louisa Greenwald	San Francisco, Cal.
26	92	40	A. M. Rexroat	Tipton, Cal.
26	93	40	E. T. Dibble	
26	86 94	200	Alice A. Nash one-half and L. Bertch one-half.	Salem, Mass. Tulare, Cal.
26	95	160	Bank of Tulare	Do.
34	95	120	.....do	Do.
34	96	40	Achille Weil	San Francisco, Cal.
34	97	240	F. H. Smith	
34	98	40	H. F. Rose	
34	99	40	Ida G. Sharp	Munson, Cal.
35	100	160	James Redfield	
35	101	160	E. W. Haughton	Springville, Cal.
36	101	80	.....do	Do.
36	88	320	Louisa Greenwald	San Francisco, Cal.
36	102	80	James Parriman	
36	103	160	A. M. Coburn	Springville, Cal.

Tulare County—Continued.

TOWNSHIP 19 SOUTH, RANGE 31 EAST.

No. of section.	No. on map.	Size of claim.	Name of owner.	Residence.
		Acres.		
18	88	120	Louisa Greenwald	San Francisco, Cal.
19	88	200	.....do	Do.
19	104	160	C. M. Stone	Tulare, Cal.
19	105	160	Martha E. Taggart	Bakersfield, Cal.
19	106	40	Elizabeth J. Shirley	Council Bluffs, Iowa.
20	88	40	Louisa Greenwald	San Francisco, Cal.
28	88	40	.....do	Do.
29	88	320	.....do	Do.
30	88	200	.....do	Do.
30	106	80	Elizabeth J. Shirley	Council Bluffs, Iowa.
30	107	160	Bella Van Valkenburg	Hanford, Cal.
30	91 89	80	George E. Guerne, in Enterprise Lumber Co.	Springville, Cal.
31	91 89	80	.....do	Do.
31	108	80	E. T. Cosper	Hanford, Cal.
31	109	80	J. M. Talbot	Santa Rosa, Cal.
31	110	80	J. M. Bowles	Do.

TOWNSHIP 20 SOUTH, RANGE 30 EAST.

No. of section.	No. on map.	Size of claim.	Name of owner.	Residence.
1	88	520	Louisa Greenwald	San Francisco, Cal.
1	85	40	F. J. Nash	Salem, Mass.
2	101	160	E. W. Haughton	Springville, Cal.
2	88	160	Louisa Greenwald	San Francisco, Cal.
2	99	40	Ida G. Sharp	Munson, Cal.
3	99	80	.....do	Do.
10	103	80	A. M. Coburn	Springville, Cal.
11	103	40	.....do	Do.
12	88	80	Louisa Greenwald	San Francisco, Cal.

TOWNSHIP 20 SOUTH, RANGE 31 EAST.

No. of section.	No. on map.	Size of claim.	Name of owner.	Residence.
6	88	80	Louisa Greenwald	San Francisco, Cal.
9	111	40	Frank T. Bowers	E. O. Miller, Visalia, Cal., agent.
16	112	640	Samuel Davis	
35	113	280	Estate of John P. Fleitz	Detroit, Mich.
35	114	160	Nellie L. Marshall	
36	113	640	Estate of John P. Fleitz	Detroit, Mich.

TOWNSHIP 20 SOUTH, RANGE 32 EAST.

No. of section.	No. on map.	Size of claim.	Name of owner.	Residence.
28	88	320	Louisa Greenwald	San Francisco, Cal.
29	88	400	.....do	Do.
31	88	40	.....do	Do.
32	88	360	.....do	Do.
32	113	80	Estate of John P. Fleitz	Detroit, Mich.
33	113	320	.....do	Do.
33	88	160	Louisa Greenwald	San Francisco, Cal.
34	113	280	Estate of John P. Fleitz	Detroit, Mich.

TOWNSHIP 21 SOUTH, RANGE 31 EAST.

No. of section.	No. on map.	Size of claim.	Name of owner.	Residence.
1	113	640	Estate of John P. Fleitz	Detroit, Mich.
2	113	240	.....do	Do.
6	113	160	.....do	Do.
7	113	480	.....do	Do.
7	115	120	James L. Miner	Poplar, Cal.
8	115	120	.....do	Do.
8	88	240	Louisa Greenwald	San Francisco, Cal.
8	113	40	Estate of John P. Fleitz	Detroit, Mich.
9	113	160	.....do	Do.
16	88	640	Louisa Greenwald	San Francisco, Cal.
17	88	400	.....do	Do.
17	113	240	Estate of John P. Fleitz	Detroit, Mich.
18	113	160	.....do	Do.

Tulare County—Continued.

TOWNSHIP 21 SOUTH, RANGE 32 EAST.

No. of section.	No. on map.	Size of claim.	Name of owner.	Residence.
		Acres.		
6	115	120	Cornelius A. Davidson	San Bernardino.
6	88	80	Louisa Greenwald	San Francisco, Cal.
6	113	240	Estate of John P. Fleitz	Detroit, Mich.
7	113	400	.....do	Do.
18	113	80	.....do	Do.

TOWNSHIP 22 SOUTH, RANGE 31 EAST.

35	113	400	Estate of John P. Fleitz	Detroit, Mich.

TOWNSHIP 23 SOUTH, RANGE 31 EAST.

1	113	640	Estate of John P. Fleitz	Detroit, Mich.
2	113	640	.....do	Do.
3	113	520	.....do	Do.
10	113	40	.....do	Do.
11	113	440	.....do	Do.
12	113	640	.....do	Do.
13	113	480	.....do	Do.

TOWNSHIP 23 SOUTH, RANGE 32 EAST.

6	113	40	Estate of John P. Fleitz	Detroit, Mich.
7	113	240	.....do	Do.
18	113	40	.....do	Do.

LUMBERING THE BIG TREES.

The lumbering of the Big Tree is destructive to a most unusual degree. In the first place the enormous size and weight of the trees necessarily entails very considerable breakage when one of them falls. Such a tree strikes the ground with a force of many hundreds or even thousands of tons, so that even slight inequalities are sufficient to smash the brittle trunk at its upper extremity into almost useless fragments. The loss from this cause is great, but it is only one of the sources of waste. The great diameter of the logs and, in spite of the lightness of the wood, their enormous weight make it impossible to handle many of them without breaking them up. For this purpose gunpowder is the most available means. The fragments of logs blown apart in this way are not only often of wasteful shapes, but unless very nice judgment is exercised in preparing the blast, a great deal of the wood itself is scattered in useless splinters. (See Pls. IX, X.)

At the mill, where waste is the rule in the manufacture of lumber in the United States, the Big Tree makes no exception. This waste, added as it is to the other sources of loss already mentioned, makes a total probably often considerably in excess of half the total volume of the standing tree; and this is only one side of the matter.

The Big Tree stands as a rule in a mixed forest composed of many species. The result of Sequoia lumbering upon this forest is best shown by the photographs. (See Pls. IX, X, XI, XII, XIII.) The destruction caused by the fall of the enormous trees is in itself great, but the principal source of damage is the immense amount of débris left on the ground—the certain source of future fires. This mass of broken branches, trunks, and bark, is often 5 or 6 or even more feet in thickness, and necessarily gives rise to fires of great destructive power, even though the Big Tree wood is not specially inflammable. The devastation which follows such lumbering is as complete and deplorable as the untouched forest is unparalleled, beautiful, and worthy of preservation. As a rule it has not even had the advantage of being profitable. Very much of this appalling destruction has been done without leaving the owners of the Big Trees as well off as they were before it began.

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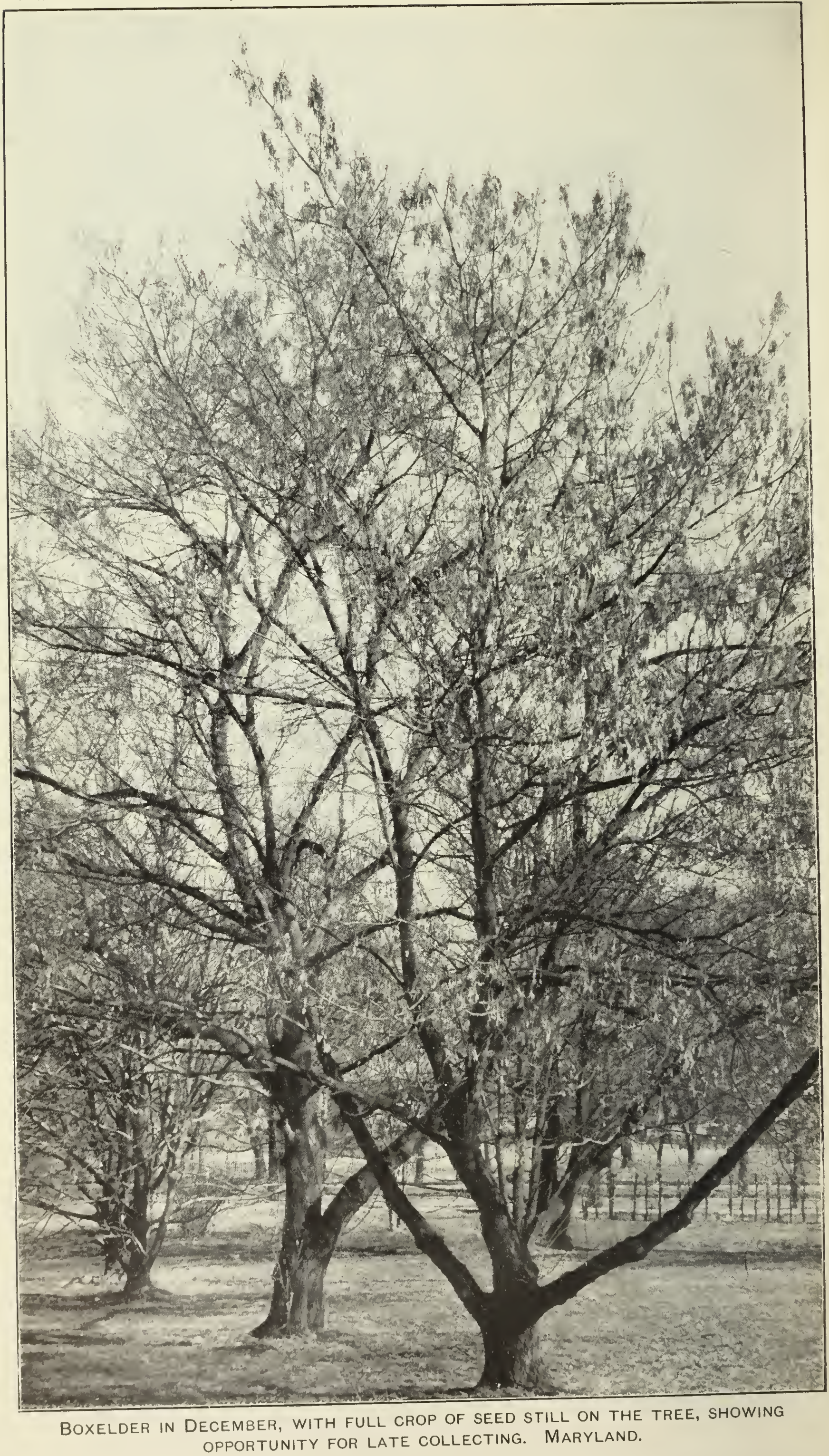

BOXELDER IN DECEMBER, WITH FULL CROP OF SEED STILL ON THE TREE, SHOWING OPPORTUNITY FOR LATE COLLECTING. MARYLAND.

BULLETIN NO. 29.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF FORESTRY.
GIFFORD PINCHOT, Forester.

THE FOREST NURSERY:

COLLECTION OF TREE SEEDS AND PROPAGATION OF SEEDLINGS.

BY

GEO. B. SUDWORTH,
DENDROLOGIST, DIVISION OF FORESTRY.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Division of Forestry,
Washington, D. C., August 1, 1900.

Sir: I have the honor to transmit herewith a paper entitled "The Forest Nursery: Collection of Tree Seeds and Propagation of Seedlings," prepared by Mr. Geo. B. Sudworth, Dendrologist of the Division of Forestry, and to recommend its publication as Bulletin No. 29 of this Division. Mr. Sudworth has brought together, in concise and original form, information of peculiar value to tree planters. His paper will be especially useful in the tree-planting work of this Division and to all farmers interested in raising trees.

Respectfully,

Gifford Pinchot,
Forester.

Hon. James Wilson,
Secretary.

PREFACE.

The purpose of this bulletin is to inform farmers and others interested in tree planting how to secure forest-tree seeds and to raise seedlings at a small cost. The professional nurseryman will find here little with which he is not already familiar. Correspondence received during the last twelve years by the Department of Agriculture from farmers and other land owners asking advice on how to procure tree seeds and how to raise seedlings shows an extensive demand for such information. Many treatises have been written on the propagation of forest trees, but most of these books lack the simpler and special instructions which the Department's correspondence shows to be in greatest demand, especially among farmers. Moreover, a great many of the books published are now out of print, or, for the most part, entirely unknown to the large class of tree planters in need of advice.

In endeavoring to give this information one point has been kept prominently in view—to lead the propagator to produce plant material which will succeed best under inexperienced management. The number of plants to be grown on the allotted space of seed bed and nursery has, therefore, been sacrificed to what is believed to be a more important consideration—the production of vigorous plants.

The treatment of the various subjects considered is based upon a long experience in collecting and storing large quantities of tree seeds and in their propagation, upon a careful study of the practices of professional nurserymen, and upon an extensive study of tree seedlings in the wild state.

Mention is made in this bulletin of the desirability of cooperation among the farmers of a locality in order that each may secure a larger assortment of seeds than would otherwise be possible. Naturally, all opportunities for private cooperation will be improved wherever feasible. In some cases, however, this cooperation will be difficult or impossible for various reasons, and the sources at hand from which to secure tree seeds may also be small. For these reasons it seems very desirable that a system of State cooperation, affording large privileges of seed exchange, be established under the direction of State experiment stations. All planters could thus be aided, and especially those with meager supplies of seed.

Under this plan, the duty of each station should be to receive the surplus seeds of various collectors in the State interested in exchange. The combined surplus would represent the exchange stock for the State, and could be so apportioned to applicants by the station that each contributing collector would receive supplies of seed not available in his locality.

G. B. S.

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THE FOREST NURSERY.

INTRODUCTION.

The art of raising forest-tree seedlings and planting trees is but little known among farmers, for whom it has very great economic interest.

For the farmer of the Eastern wooded country, the study of how to grow trees has not yet reached, nor is it likely to reach, the same degree of importance as for the Western farmer. The Eastern farmer has often to consider only what trees shall be allowed to grow up and what shall be introduced, while the Western farmer has to consider what may be grown and how. The greater interest centers about the Western planter because of his greater need for wood material, and also because the growth of trees under his conditions is most difficult.

The importance of establishing wood lots or shelter belts on farms that lack them is no less obvious than the necessity of raising the staple crops. The provident farmer can not afford to buy firewood, fence posts, or building timber any more than he can afford to buy corn and wheat. A part, if not all, of the wood material used on the farm can and should be grown there. The profit on this timber growth rightly belongs to the farmer, and it is therefore one which economic agriculture can not neglect.

The relative value of wood lots in the prairie region and the wooded East is, of course, different. To the prairie farmer the possession of a wood lot affording posts, rails, poles, and firewood is of very great importance, since, being in a treeless region and distant from the sources of wood supply, he would otherwise be compelled to pay high prices for such material. The Eastern farmer is less dependent, even though his wood lot has been cut off, for he lives in a wooded country, where posts, fuel, and lumber are comparatively cheap.

The scope of the farmer's tree planting will necessarily be small. In order to be entirely successful, smaller tree-planting operations should give useful results within one man's lifetime. To accomplish this the farmer tree planter must confine his attention chiefly to quick growing trees.

The efforts under the Timber Culture Act to establish forest growth in the plains region of the West can hardly be said to have been successful beginnings in forest planting; they were, however, attempts to meet the great necessity for timber in that region. Their failure has not demonstrated that trees can not be grown there, but rather that there is need of a better system and a more intimate knowledge of the special requirements of trees under trying conditions. For, however little evidence there is now that forests once existed to any extent on the Western plains, it is believed that trees can be made to grow in this region.

If forests ever existed in this nearly treeless region, with their disappearance has gone every chance of their unaided return. Here wild prairie land, or land left long uncultivated, rarely gathers upon its wind-swept surface the little islands and groves of trees so common in the East under precisely the same conditions of clearing. The trees that do exist are found only along the streams. The clearest inference from this fact is that the land, except adjacent to streams, lacks the soil moisture necessary to the natural reproduction of trees. In the East frequent rains and a humid climate give this moisture to the poorest soil. As a result, abandoned cleared fields quickly return to forest whenever the absence of heavy grazing and fire allows it. On the other hand, the deep, rich soils of the Western plains are reduced to semiaridity by the combined effects of scanty rainfall and hot drying winds. Even if tree seeds germinate under these unfavorable conditions, the tender seedlings speedily wither and die.

Some forest trees are at home in widely different soils and climates. Other trees can exist in certain kinds of soil only or in certain climates or surroundings. If not dependent upon these conditions for their whole life, they are so for the early part of it. The absence of one of these factors, as for example, an evenly moist soil, or protection against hot drying wind during the early critical period of a tree's life, means the failure of the species to extend unaided over areas where otherwise it might become established. The thousands of bushels of black walnuts planted in the plains region of the West did not fail to germinate; but many of them failed to produce trees, for the very good reason that the seedlings lacked a continued supply of soil moisture. The thin foliage could not produce enough shade to prevent the rapid evaporation of melted snows and spring rains. Without shade to conserve these waters to the soil, and with few or no summer rains and no irrigation, it was natural that so many walnut plantations should have failed in the drier plains regions.

In attempting now to establish forest trees in such dry treeless regions, the chief problem is to overcome these unfavorable conditions. This can be accomplished best by first starting the young seedling in the seed bed and growing it in the nursery until it is strong enough to maintain itself in the forest plantation. If the special needs of seedlings and young trees pointed out in this bulletin are supplied, the Western farmer may as successfully grow trees from the seed to maturity as he can farm crops. The eastern farmer has still better chances of success.

COLLECTING TREE SEEDS AND CARE BEFORE PLANTING.

ECONOMY OF COLLECTING TREE SEEDS.

Home collecting of seeds makes forest planting possible for the farmer, while the necessity of purchasing seed may place it beyond him.

The farmer or other land owner who contemplates planting forest trees must provide his stock either by raising it or buying it. To the average farmer the cost of this planting material, however small, is likely to be an important consideration. It is, therefore, always desirable and often indispensable that the farmer, by collecting seeds and raising seedlings himself, should reduce the cost of forest planting as much as possible. Most farmers can, without inconvenience or extra expense, give the attention and labor necessary for planting and cultivation.

REGIONS OF SEED SUPPLY.

Broadleaf trees are most abundant in the East, with some desirable conifers; only a few broadleaf kinds are found in the plains region, and conifers are abundant in the mountain regions of the West. Cooperation of farmers is important for a general supply.

It will often be difficult to find in one locality all the desirable kinds of trees from which to collect seed. The prairie regions will afford a limited number of broadleaf[1] tree seeds; the Western mountain regions, an abundance of coniferous seeds with a few broadleaf kinds; while the Eastern States will supply the largest number of broadleaf, together with some of the most desirable coniferous seeds.

Even in regions of abundant supply some localities will be poor in certain seed trees which a neighboring locality may contain in abundance. Under such circumstances cooperation between planters should lead to exchanges or other arrangements through which the lacking material may be obtained.

SEED COLLECTORS AND COST OF SEEDS.

Seed collecting is carried on mostly by nurserymen and professional collectors. The cost of seed is high because of the smallness and irregularity of the demand, the uncertainty of the crop, and the difficulty of collecting and keeping in growing condition.

Few persons are familiar with collecting tree seeds because it is confined chiefly to nurserymen and professional collectors. The price of tree seeds is usually very high, as compared with that of most field and garden seeds, partly because the demand for tree seeds is small and very irregular. Moreover, unlike field and garden seeds, a full and regular crop of tree seeds can not be found in all localities every season; since the habit of many kinds of trees is to bear seed only at intervals of from two to four years, or, on account of special accidents (frost, fire, etc.), at even longer intervals. In addition, the process of gathering tree seeds is for the most part more laborious than that of any other class of seeds. Trees must be climbed and the seeds picked off by hand, or the branches must be severely shaken or beaten to dislodge it. The wasteful practice of lopping off branches or cutting down trees solely to get the seeds should not be resorted to. The seeds of only a few trees, like the hickories, beech, walnuts, butternut, chestnut, oaks, etc., can be easily gathered after severe frosts and winds have made them fall.

---

[1] The term "broadleaf" is used here to designate all trees not conifers (Pines, Spruces, Firs, Larches, Hemlocks, etc.), being preferred to "deciduous" and "hardwood." "Deciduous" is incorrect for designating nonconiferous trees for the reason that many of these trees are evergreen. The term would also include some strictly deciduous-leaf conifers. The term "hardwood" is misleading, because it is often made to include woods both hard and soft, while in lumber markets it is used in contradistinction to the term "softwood," which is applied both to conifers and to some broadleaf trees.

The market price of tree seeds is enhanced also by the special care and devices necessary to preserve them in good condition until wanted for fall or spring planting. Only a few seeds can be planted immediately after they are gathered.

LIST OF MARKET PRICES FOR TREE SEEDS.

The following list shows the present range of market prices for tree seeds, to which must be added the cost of transportation:

Market prices for tree seeds.

Name of species.	Cost of seed per pound.	Name of species.	Cost of seed per pound.
Black Spruce	\$3.75–\$4.00	Bitternut Hickory	\$0.15–\$0.25
White Spruce	3.75– 4.00	Beech	.50– .75
Engleman Spruce	3.00– 8.00	Black Walnut	.10– .15
Blue Spruce	2.00– 6.00	Butternut	.10– .20
Sitka Spruce	3.50– 4.00	White Ash	.30– .60
Douglas Spruce	2.50– 4.50	Green Ash	.50– .75
White Fir	1.50– 5.00	Blue Ash	1.00– 1.50
Alpine Fir	2.50– 5.00	Oregon Ash	1.50– 2.00
Balsam Fir	1.25– 3.00	Black Ash	.75– 2.00
Noble Fir	3.00– 5.00	Red Ash	.75– 1.50
White Pine	1.50– 3.00	Sugar Maple	.75– 1.00
Sugar Pine	2.00– 2.50	Broadleaf Maple	.75– 1.00
Silver Pine	3.50– 4.00	Red Maple	1.25– 1.75
Limber Pine	4.00– 5.00	Silverleaf Maple	1.00– 1.50
Pitch Pine	2.50– 3.00	Box Elder	.35– .50
Bull Pine	2.00– 3.50	White Birch	1.50– 2.00
Longleaf Pine	3.00– 5.00	Sweet Birch	1.50– 2.00
Jack Pine	7.00–12.00	Yellow Birch	1.00– 2.00
Lodgepole Pine	7.50– 8.00	American Elm	1.00– 1.50
Lawson Cypress	3.75– 4.00	Cork Elm	1.50– 2.75
Red Cedar	.50– .75	Catalpa	.50– 1.25
Arborvitæ	2.00– 2.25	Black Locust	.50– .75
Giant Arborvitæ	3.00– 4.50	Honey Locust	.40– .60
Incense Cedar	3.00– 4.00	Black Gum	1.00– 1.25
Larch	12.00–16.00	Sweet Gum	2.50– 3.00
Big-tree	4.00– 6.00	Tulip-tree	.40– .50
Redwood	3.00– 5.00	Cucumber-tree	1.00– 1.50
Bald Cypress	.75– 1.00	Evergreen Magnolia	1.25– 1.50
White Oak	.10– .25	Osage Orange	.25– .30
Burr Oak	.20– .25	Black Cherry	.40– .60
Overcup Oak	.25– .30	Ailanthus	.25– .50
Spanish Oak	.30– .40	Persimmon	.75– 1.00
Red Oak	.20– .25	Holly	.75– 1.25
Black Oak	.15– .25	Basswood	1.00– 1.25
Shellbark Hickory	.15– .25	Sycamore	.50– .75
Pignut Hickory	.15– .20	Hackberry	.75– 1.00

SEEDS DESIRABLE TO COLLECT.

Secure seeds of as many of the useful timber trees of the home locality as possible. If these are slow-maturing trees, an assortment of fast-growing trees should be added; or, if the home trees are all quick-maturing trees, these may be supplemented by a few slower-growing kinds. Trees at home in a warm climate should not be planted in a cold climate. Trees from the northmost localities in the range of a species are more desirable than those from southern parts of the range. Seeds are best propagated in soils similar to those in which the parent trees grew.

The kinds of seeds desirable to collect will be determined largely by the purpose of the planting and by the kinds of trees adapted to the climate and soil at hand. For wooded regions the seed should be collected from as many of the timber species as are available. These may be represented now only by scattered individuals in the fence corners or elsewhere. They should not be overlooked. They are adapted to the region, and require no experiments to determine their fitness. Among such trees will be found Oaks, Walnuts, Hickories, Ashes, Elms, Sycamores, Beech, Maples, Cherry, Tulip-tree, Pines, Firs, Spruces, Hemlocks, and Larches. Most of them require at least seventy-five to one hundred years or more to reach maturity; but much useful timber will be produced by them in thirty to fifty years. To these must be added some faster-growing kinds, such as will give useful timber in ten to thirty years. Among these are Red Oak, Chestnut, Red and Silver Maple, Boxelder, Hardy and Common Catalpa, Black and Honey Locust, Cottonwood, Aspen, Largetooth Aspen, and Black Willow.

For the treeless regions, the small number of species available for the planter (Cottonwoods, Willows, Boxelder, Green Ash, Elms, etc.) may be supplemented by seeds from the timbered States. The choice of these must be based upon some knowledge of the soil and climate required by each species. All trees can not be successfully grown in any soil or climate. For example, the Bald Cypress of Southern swamps, or any other strictly Southern tree, will not endure the cold of a Minnesota winter. There are, however, many valuable timber trees that grow naturally from Canada to the Gulf States; and several extend even from the Atlantic to the Pacific coast. Among desirable trees, native in the Rocky Mountains, the Yellow Pine, Red or Douglas Fir, Rocky Mountain Juniper, and White Fir have already been successfully grown in the plains region far outside their natural range. Of Eastern trees, the White, Red, and Jack Pines, White Spruce, Red Cedar, White Birch, Sycamore, Black Cherry, and Black Walnut have been established in the same region. A few trees from this list, taken with the available local trees, will give the prairie planter an assortment large enough for all practical purposes. The planter is recommended to confine his operations to a small number of useful kinds, and preferably to those which grow naturally about his home.

Of seed grown outside the home locality, that from the most northern locality in the range of the species is preferable, because it will produce hardier plants than seed from more southern stations. Seeds should be taken from trees which are growing in soil as similar as possible to that in which the new stock is to grow. Individual trees of some species of forest trees are found growing naturally in both

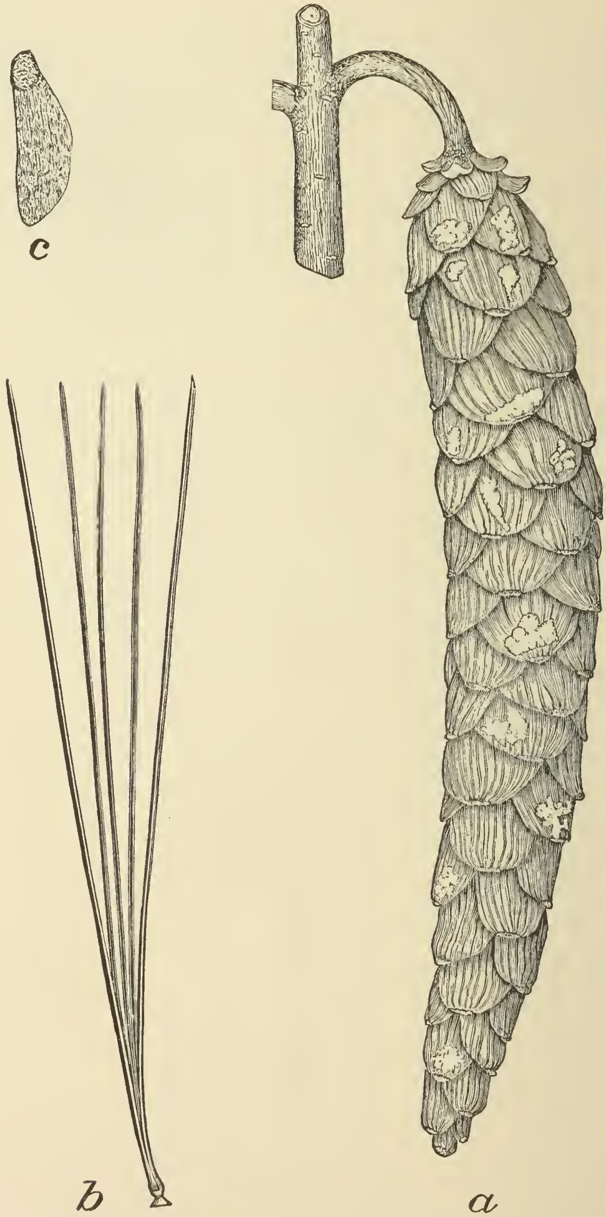

FIG. 1.—White Pine: *a*, Closed mature cone; *b*, leaf bundle; *c*, seed. (Natural size.)

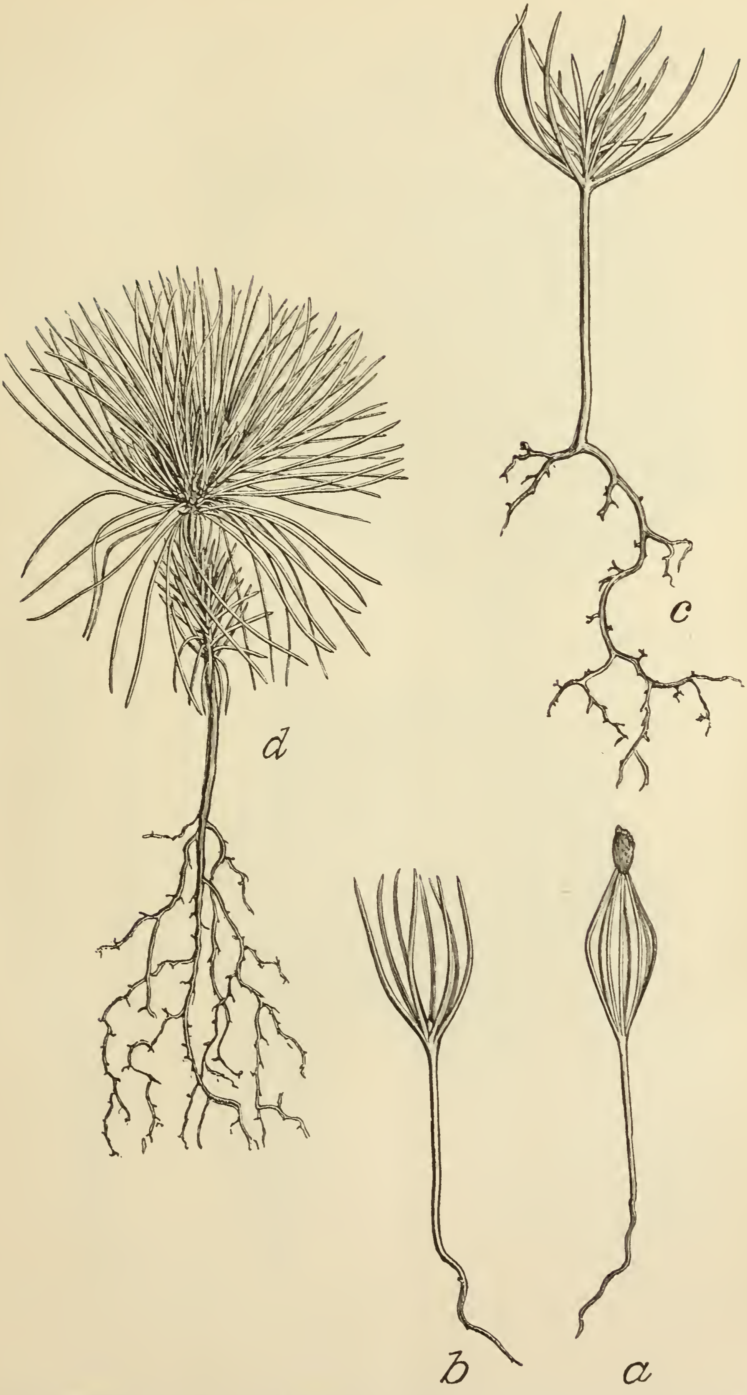

FIG. 2.—White Pine: *a*, *b*, *c*, *d*, development of seedling from germination to the second year.

rich moist soils and in very dry or poor soils. Stock raised from seed trees growing under either of these extreme conditions usually does better if placed in a soil similar to the one in which its parents grew. There are, however, some exceptions to this. Thus the Eastern Larch, which grows exclusively in moist mucky swamps, may be propagated in loose upland soils. As a rule, plants from seed trees grown in poor dry soils do well in rich moist soils, while plants from seed trees grown in rich moist soils are less at home in poor dry soils.

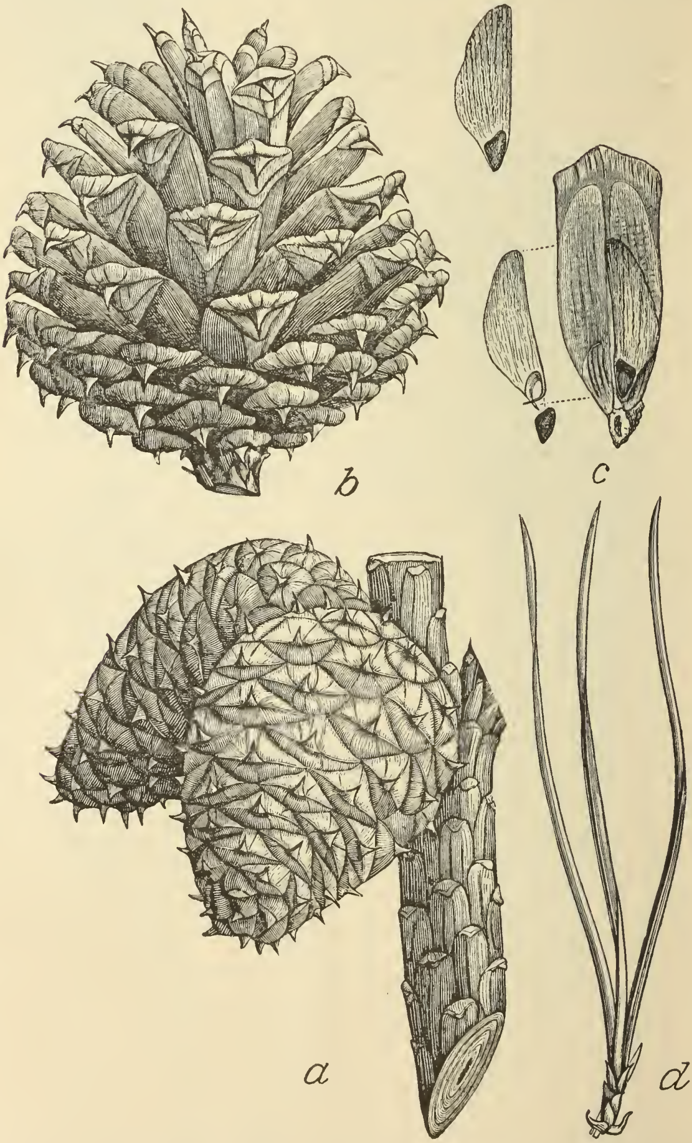

Fig. 3.—Pitch Pine: *a*, Closed and, *b*, open mature cones; *c*, lower side of detached cone scale and seeds; *d*, leaf bundle. (Natural size.)

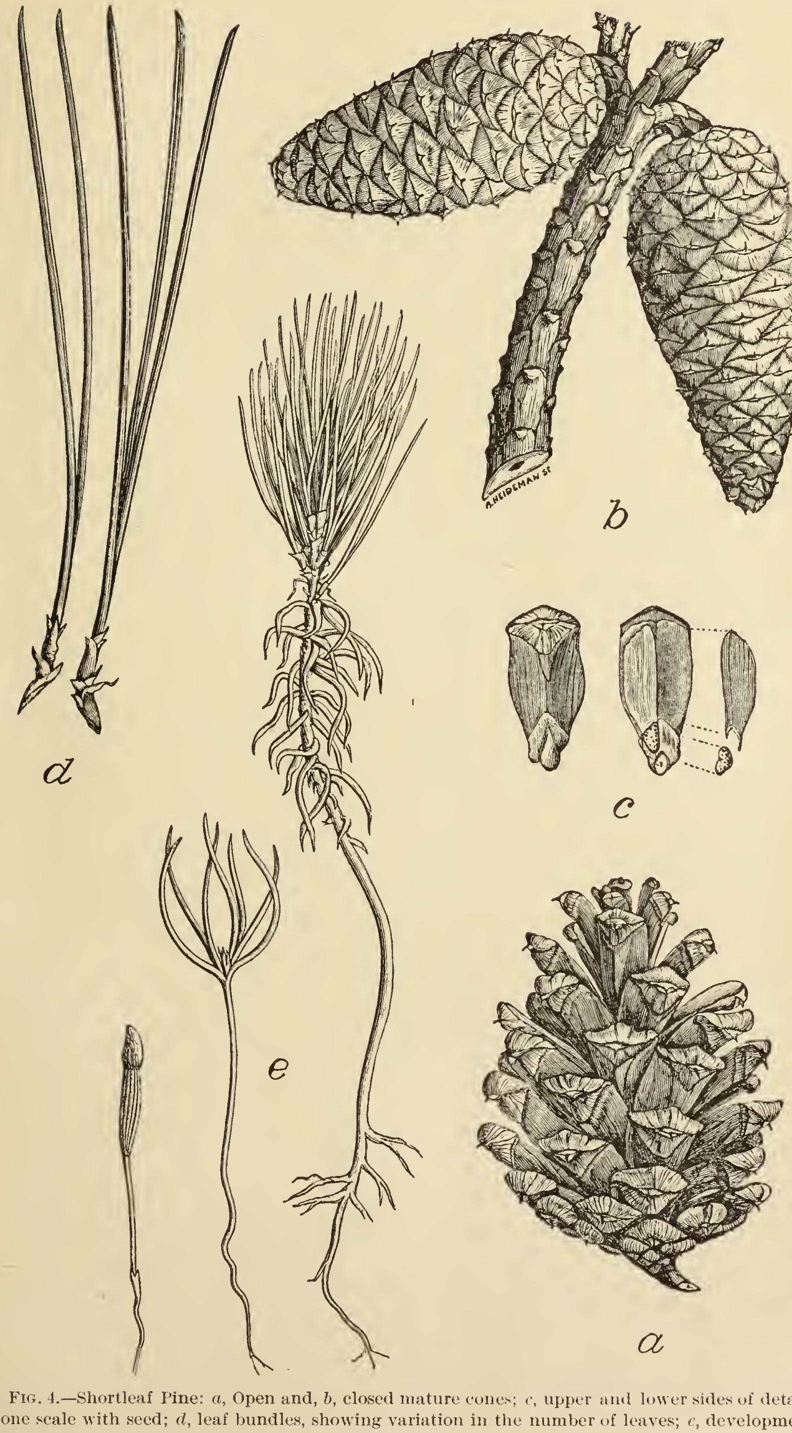

FIG. 4.—Shortleaf Pine: *a*, Open and, *b*, closed mature cones; *c*, upper and lower sides of detached cone scale with seed; *d*, leaf bundles, showing variation in the number of leaves; *e*, development of seedling from germination to first year. (Natural size.)

WHEN TO COLLECT SEEDS.

A few kinds are collected from April to July; the majority of tree seeds are gathered from September to November. Do not fail to collect seed during a prolific seed year. Watch should be kept to see that squirrels and other animals do not carry off the seed crop first.

The time for collecting forest tree seeds varies from April to November, according to the kind and the region in which they are grown; a few pines with cones which open tardily, such as the Jack Pine, Pitch Pine, Lodgepole Pine, etc., may, except for the cold to which the collector is subjected, be secured during the winter. It is possible also during the winter to collect the seeds of Boxelder, Black and Honey Locust, Kentucky Coffeetree, Ashes, Catalpas, and others, since a large part of the crop may often cling to the trees for several months. (See frontispiece.) Large quantities of Honey Locust and Kentucky Coffeetree pods are usually thrown down by wind during the fall and early winter, and may then be easily picked up (see Pl. I, fig. 1). Care must be taken that hogs or cattle do not destroy locust pods before they can be gathered. It is not well, however, to depend too much upon winter collecting, for then the presence of seeds is largely accidental. Several broadleaf trees, such as Red and Silver Maple, and Elms, mature their seeds in the spring or early summer months, but the majority of tree seeds are ripe from September to November.

It is important to observe that seed production with some trees is variable. Few trees bear a full crop of seed annually, but usually at intervals of two to three years, or occasionally at longer intervals. Seed should, therefore, be gathered from trees whenever they bear a good crop, for the next year's crop may be small, or the seeds may be imperfect, or it may fail altogether. It sometimes happens, from no apparent cause, that the seed borne by a tree is much more perfect one season than another.

No rules can be given for the exact time when tree seeds should be collected. By studying the table on pages 60–63, which indicates months in which certain species ripen their seed, the collector can ascertain approximately when to look for seeds.

Care should be taken not to gather seed until it is thoroughly ripe. This may often be more or less difficult to determine; but the brown and yellow tints assumed by ripening tree fruits are quite readily recognized as indications of maturity. In addition to these external signs, ripeness will be recognized in the firm, full condition of the seed when cut or cracked open. The well-known ripened appearance of pulpy fruits, such as Apples, Haws, Mulberries, Cherries, will always indicate mature seed. The cones and cone-like fruits are exceptional in not always giving external signs of the maturity of their concealed seeds. Thus the cones of the Pines, Spruces, Firs, Larches,

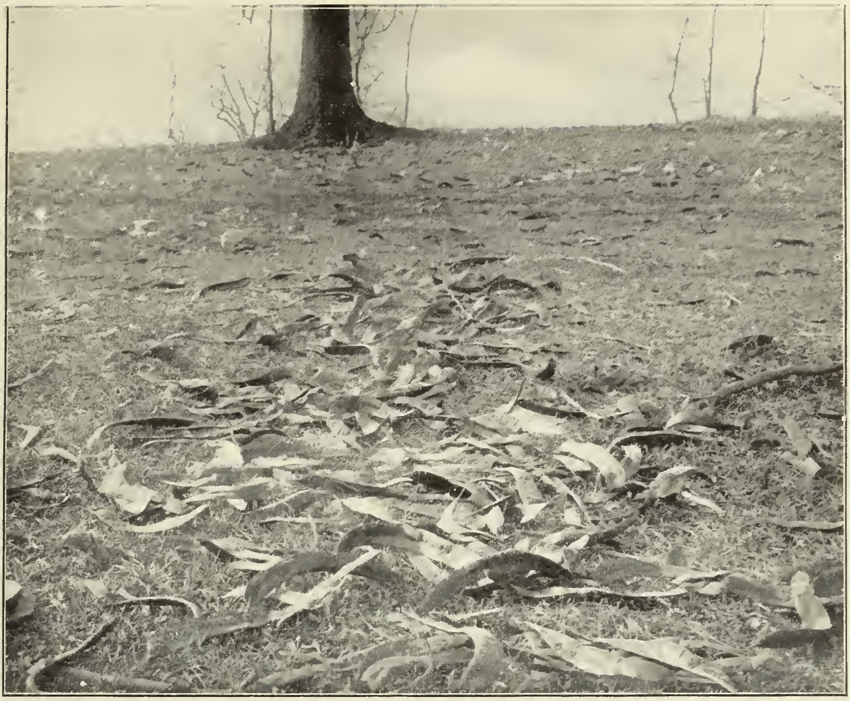

FIG. 1.—HONEY LOCUST SEED PODS THROWN BY WIND, SHOWING OPPORTUNITY FOR SECURING SEEDS EASILY IN MILD CLIMATE, DECEMBER. MARYLAND.

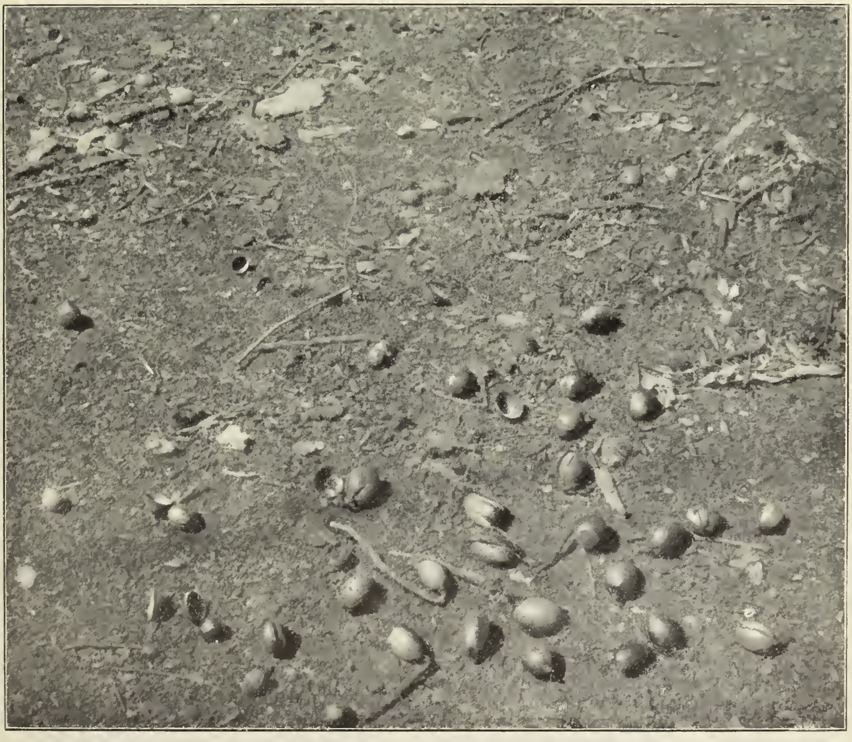

FIG. 2.—CHESTNUT OAK ACORNS AFTER AN EARLY SPRING FOREST FIRE HAS BURNED OFF THE PROTECTING COVER OF LEAVES, SHOWING THE GERMINATION LAST FALL OF SEVERAL ACORNS UNDER THIS PROTECTION. MARYLAND.

Hemlocks, Cypress, Arborvitæs, Birches, Alders, and Tulip-tree have mature seeds under their scales from one to several weeks before the cones appear to be ripe; in fact, cones with ripe seeds may appear quite green externally (see figs. 1, 3, 4, 6, 7). The ripeness of seeds in

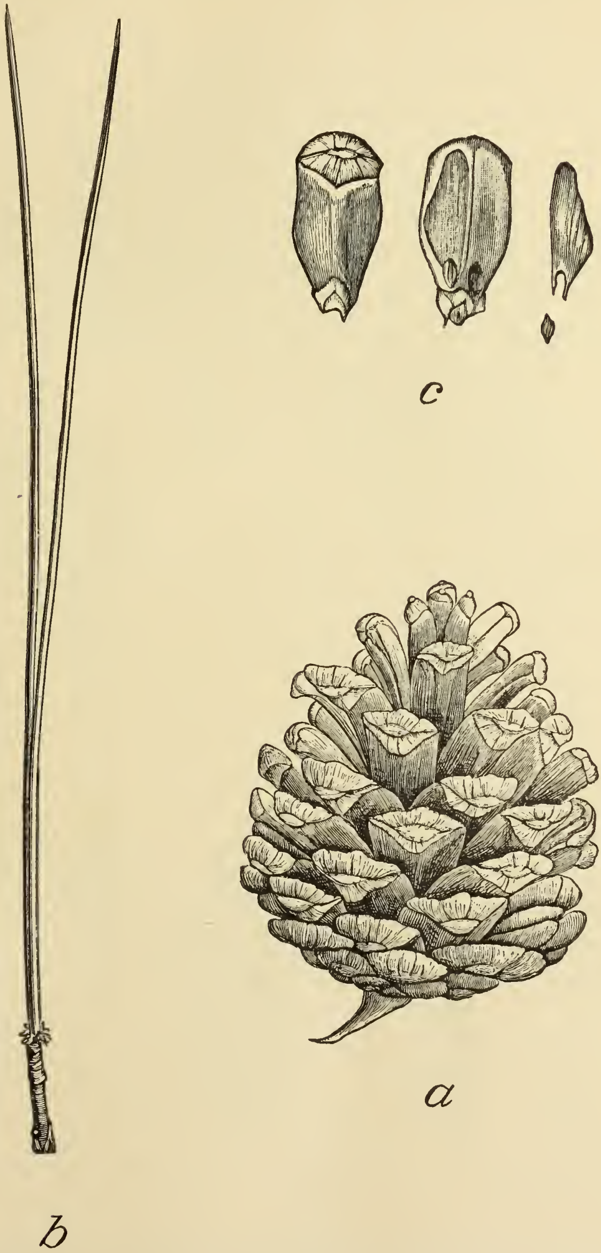

Fig. 5.—Red Pine: *a*, Open mature cone; *b*, leaf bundle; *c*, upper and lower sides of detached cone scales with seeds. (Natural size.)

cones of immature appearance can be quickly determined by cutting through the cones at various angles with a sharp knife. If the seeds be ripe, the full whitish flesh of the cut seeds will be seen between the overlapping cone scales; the coverings of the seeds will also have a

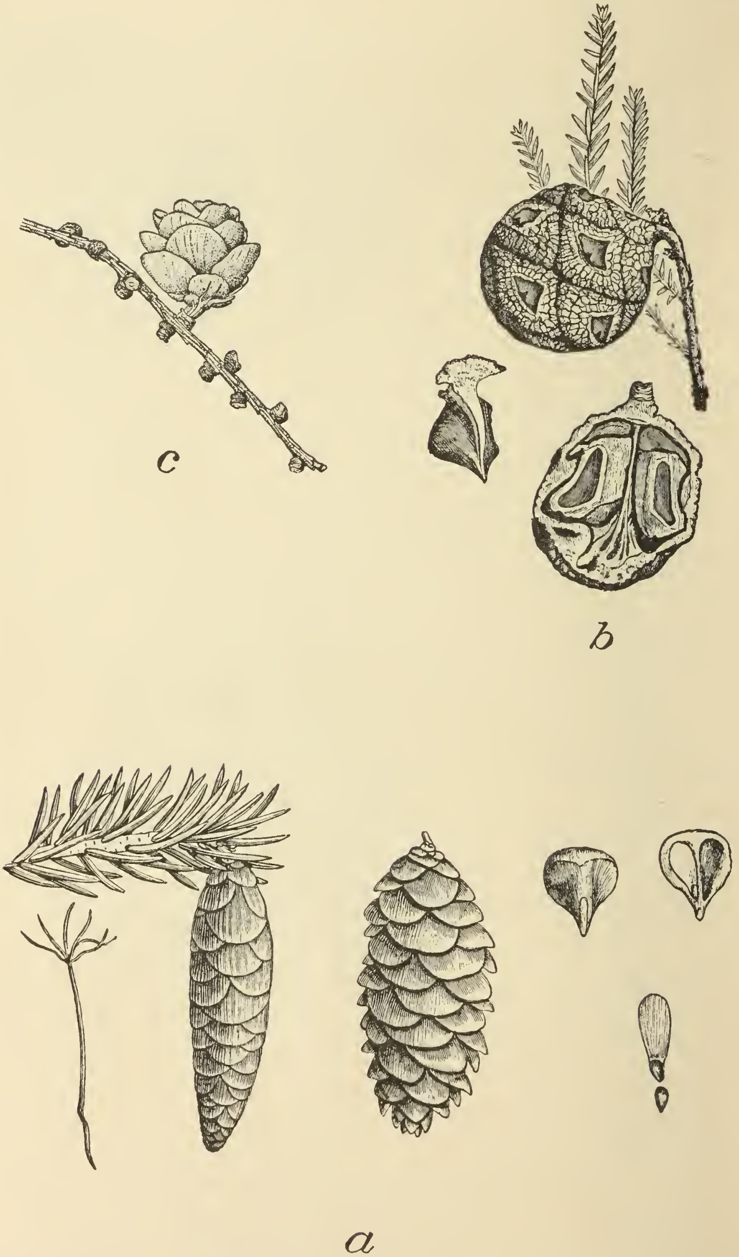

Fig. 6.—Cones and seeds: *a*, White Spruce, closed and open mature cones, and upper and lower sides of detached scale and seed (seedling 10 days old); *b*, Bald Cypress, mature cone, section of same, and detached seed; *c*, open mature cone of Tamarack. (Natural size.)

brownish, mature appearance, in contrast with the greenish cone scales. If these signs be present collecting should begin at once.

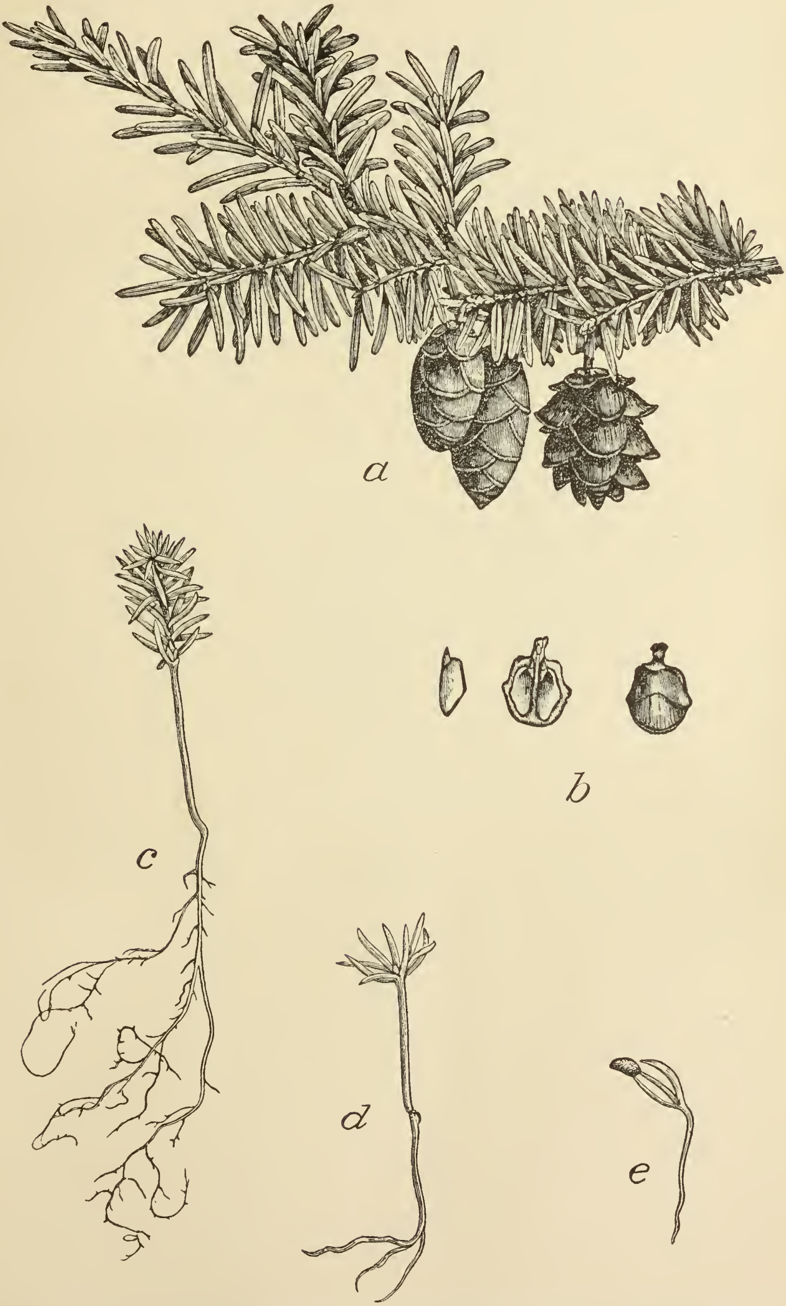

Fig. 7.—Hemlock: *a*, Branchlet with open and closed mature cones; *b*, upper and lower sides of detached cone scale and seed; *e*, *d*, *c*, development of seedling from germination to first year. (Natural size.)

If left to dry on the trees the mature cones of the Bald Cypress, Firs, Birches, and Tulip-tree will soon lose their seeds by falling to pieces, while the cones of Pines (excepting species with close cones), Spruces, Larches, Hemlocks, Cypresses, and Arborvitæs with persistent cone scales, will lose their seeds by the opening of the scales (see figs. 3, 4, 5, 6, 7). The pine squirrels are knowing collectors, and begin to cut the pine, spruce and fir cones before they open and lose their seeds. All such cone fruits should therefore be promptly gathered as soon as the seeds are found to be well matured. In the western mountain regions, where the seeds of conifers are eaten so extensively by squirrels, it is especially important to keep watch and gather the cones before these animals get them.

WHERE TO COLLECT SEEDS.

Field or roadside trees bear the largest crops of seeds, and their crowns are low and easy of access. Trees in open forests and on the borders of denser growths are the next most desirable, but are more difficult to collect from.

Among broadleaf trees the greatest amount of seed is produced by those growing in the open, where, in the full enjoyment of light they develop low, broad crowns. Every country lad knows that the Hickories and Walnuts growing in fields and fence corners bear the best and the largest quantities of nuts. The low stature of these field trees will also afford the easiest collecting. If none of these are at hand, trees along the border of a forest and those in an open or scattered stand will give the next best supplies of seeds, but on account of their usually greater height of crown forest-grown trees will be more difficult to collect from.

Among conifers also scattered trees and those in an open forest are generally more productive of seed than trees in a dense stand. But such conifers as Spruces, Firs, Larches, and Arborvitæs, which have narrow conical crowns, bear seed chiefly at the top, and are therefore very productive even in a moderately close stand.

It is important to note that the difficulty of collecting some coniferous seeds is much less among mountain-grown trees. This is especially true of conifers in the western mountain regions. It would be quite impossible to collect seed from some of the lofty Sugar Pines, Yellow Pines, and Firs of those regions except by felling the trees. At high altitudes, however, low, stunted trees may often be found heavily loaded with cones which are easily gathered. The cones of such trees are quite as large as those on taller trees, and the quality of the seed appears not to be inferior.

It is fitting to remark in this connection that farmers will find it most profitable to encourage the growth of any forest trees which chance to spring up in fence corners, and to a limited extent in fields, for the purpose of seed production. A supply of at least a few kinds of tree seeds could thus be had at home.

Walnuts, Butternuts, Hickories, Oaks, Beeches, Cherries, Elms, and Maples are familiar shade trees scattered over many farms in the natural range of the species and are valuable for the seed they produce. Every farmer, at least in the naturally wooded States, could, without much trouble, maintain a full collection of indigenous trees planted or allowed to spring up in fence corners and waste places for the purpose of seed production. With a more general demand for tree seeds some profit would eventually be derived from such a stock.

HOW TO COLLECT SEEDS.

Small seeds (of Ashes, Maples, etc.) and cones must be picked from the trees by hand, and are, therefore, the most difficult to collect. Large seeds (acorns, hickory nuts, walnuts, beechnuts, etc.) can be gathered after they have fallen. Cutting down trees or lopping branches or tops to get seed is destructive to seed trees, and should not be resorted to.

Tree seeds must be collected chiefly by hand picking. Certain classes of them, such as the seeds of the Oaks, Hickories, Walnuts, Butter-

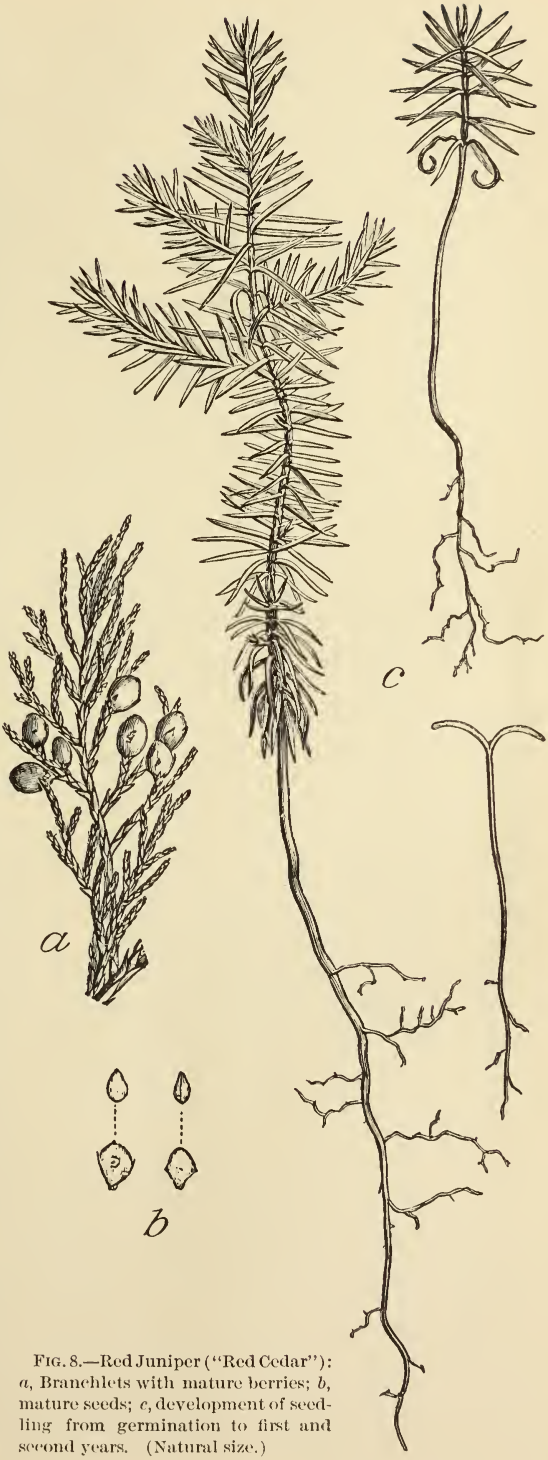

Fig. 8.—Red Juniper ("Red Cedar"): *a*, Branchlets with mature berries; *b*, mature seeds; *c*, development of seedling from germination to first and second years. (Natural size.)

nuts, Chestnuts, and Beeches, which fall readily with wind and severe frosts, can be collected with less difficulty than other tree seeds, since they need only to be gathered from the ground (Pl. I and fig. 11). The hulls of beechnuts are usually opened by successive frosts, and often hold the nuts for several days, during which they can be whipped or shaken from the tree and caught on sheets or blankets spread underneath.

The seeds of the Ashes, Maples, Boxelder, Cherries, Hackberries, Locusts, Elms, etc., together with all cones, should be picked from the tree by hand (see frontispiece and fig. 8). When the trees stand on smooth ground, Silver Maple seed may often be secured after they have fallen. The seeds are so large and usually so abundant that they can be easily raked up (see figs. 9 and 10). There are also occasional opportunities of securing Maple and Ash seeds which have fallen into streams and have been thrown ashore in little "drifts."

The temptation to cut off large branches, or the leaders of Firs and Spruces, or even to cut down certain trees to get the seed should always be resisted, except when the trees are at the same time wanted for timber. An occasional judicious pruning of small branches (cutting off 1 to 2 feet) to secure difficult clusters of seed will do no harm, and in the case of many roadside or field trees a general pruning may even be desirable to keep a spreading crown within proper limits. With broadleaf trees the effect of such trimming is quickly repaired by new shoots. On the other hand, the leaders of Spruces and Firs, which bear the bulk of the cones, should never be cut off for the sake of securing the seed. Permanent injury is likely to result from decay admitted at the point where the top is cut off; in addition, the place of the leader is not always fully supplied by a lateral top branch bending and growing upward. At best the new leader is bayonet shaped and in danger of being stunted.

Pruning shears mounted on a long pole will be useful for clipping off broadleaf branchlets too high to be otherwise reached with safety. A pair of climbing irons, similar to those used by telegraph linemen, with rounded, chisel-pointed spikes are used by professional seed collectors, and greatly facilitate the climbing of both tall and low trees.

PRELIMINARY TREATMENT AND CARE OF FRUITS AND SEEDS.

Cones of Pines, Spruces, Hemlocks, Larches, Cedars, Cypresses, and Alders are dried till the scales open, when the seeds are whipped out. Pulpless pods (Black Locust, etc.) are treated similarly. Cones of Firs, Birches, and Tulip-tree are dried till they fall to pieces, and the seeds are sifted from the scales. Pulpy pods (Honey Locust, etc.) and pulp fruits are macerated in water till the seeds can be washed out. Thick hulls of nuts are removed. Most seeds and nuts require superficial drying.

After they are collected, the fruits of many trees, such as the cone-bearers, a few Oaks and Hickories, Osage Orange, Walnuts, Butternuts, Mulberries, Locusts, Kentucky Coffeetree, Cherries, Apples, and others require special treatment to separate the seeds from the pulp or hulls, or to fit them for keeping till they are sown. This treatment consists in drying cones and some other fruits as nuts, or in macerating pulpy pods, cherries, plums, and berries, till the seed can be washed out. The drying can be done out of doors in the sun or in a warm room. An artifical heat of 70° to 75° F. will be sufficient. High temperatures injure the vitality of the seeds.

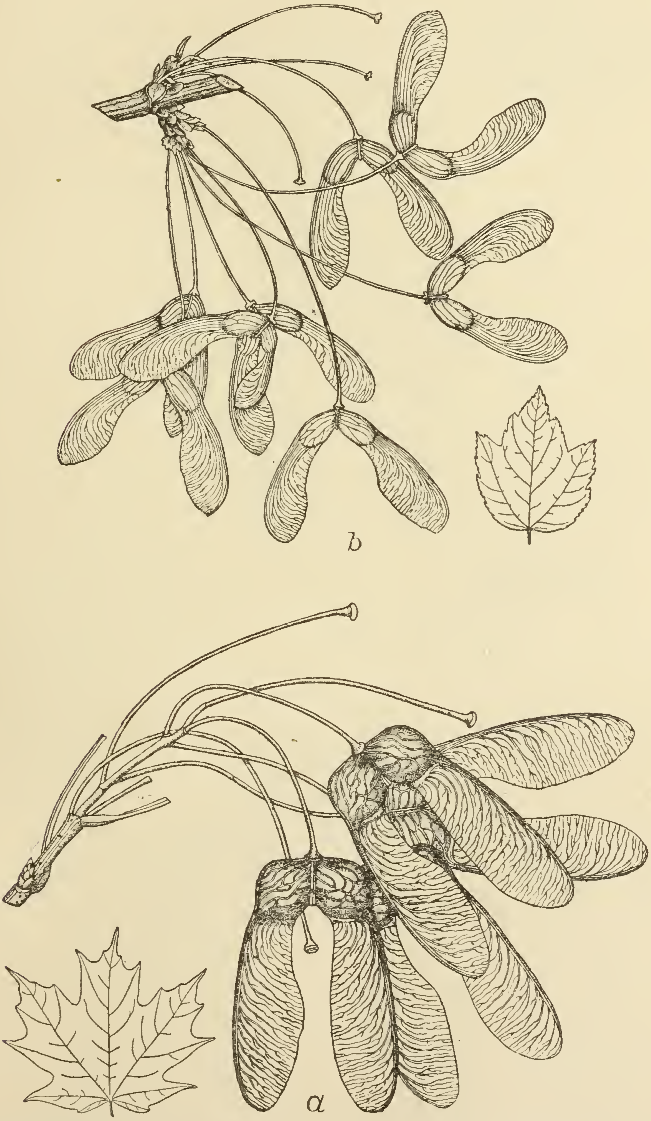

FIG. 9.—Seeds and leaves: *a*, Sugar Maple, mature seed (natural size), mature leaf (¼ natural size); *b*, Red Maple, mature seed (natural size), mature leaf (½ natural size).

If dried in a room, the material should be, according to the quantity

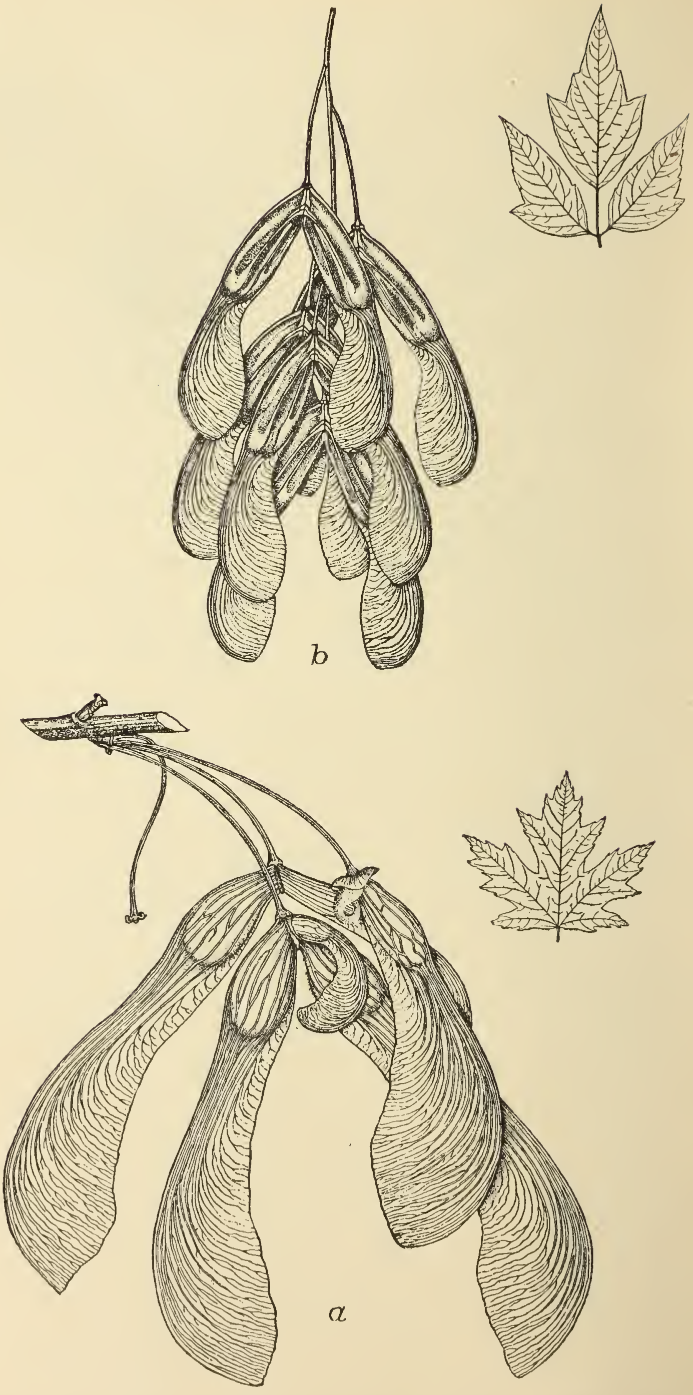

FIG. 10.—Seeds and leaves: *a*, Silver Maple, mature seed (natural size), mature leaf (¼ natural size); *b*, Boxelder, mature seed (natural size), mature leaf (¼ natural size).

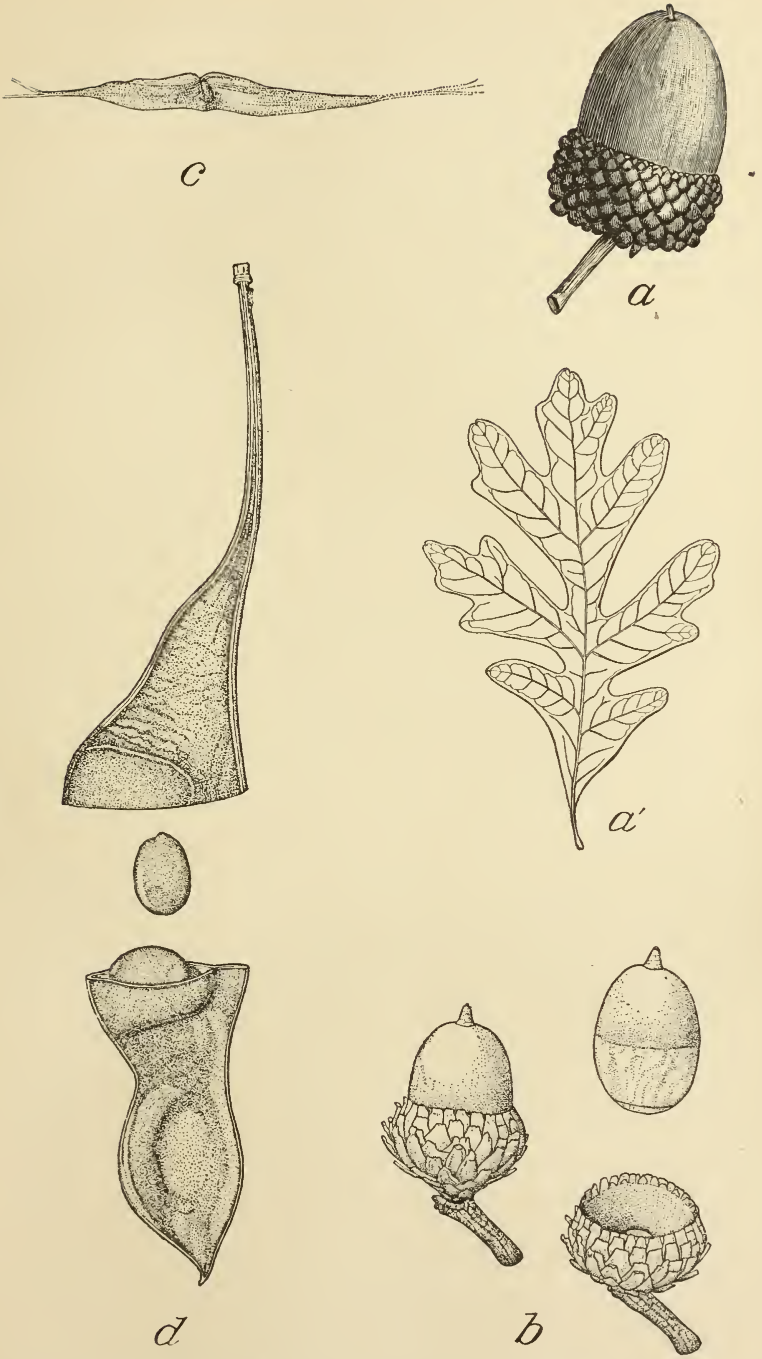

FIG. 11.—Acorns, leaf, seed, etc.: *a*, White Oak, mature acorn (natural size), mature leaf (⅓ natural size); *b*, Black Oak, mature acorns (natural size); *c*, seed of common Catalpa (natural size); *d*, Honey Locust, extremities of mature pod and detached seed. (Natural size.)

and available space, spread upon a clean, tight floor, or upon shallow tight-bottomed trays arranged one above another in racks; the nearer the latter are to the top of the room, the quicker the drying will be accomplished. If the drying is done in the sun, the material should be spread on a tight board floor, flat roof, trays, or a canvas or other sheet. Drying fruits should always be protected from rain. In out-of-door drying care should be taken also to protect the lighter seeds from being blown away as they are shelled out. The seeds of Pine, Spruce, Fir, Larch, Hemlock, Tulip-tree, and others, are easily disturbed or carried away even by a light breeze.

When the cones of Pines, Spruces, Hemlocks, Larches, Arborvitæs, Cedars, Cypresses, Sequoias, and Alders are thoroughly dry the scales will open out and liberate the seeds. The extracting of the seeds will then be greatly hastened by whipping the cones or brushing them about briskly, till all the seeds have fallen out. As a rule very little jarring is required to dislodge all the seeds from dried White Pine and other thin-scaled cones. The same is true of the Spruces, Hemlocks, Larches, and Arborvitæs.

The labor of separating seeds from the small cones of such species as Arborvitæs, Cedars, and Cypresses may be shortened by sifting the mass of seeds and cones with a sieve of the right size to let the seeds through and retain the cones.

A few species, such as the Jack Pine, Table Mountain Pine, Pitch Pine, Lodgepole Pine, Pond Pine, Sand Pine, Knobcone Pine, have thick, strong scales, which in nature often remain closed for several years, in some instances never opening at all. Such cones require careful and thorough drying to open the scales, which, however, rarely fail to open when a sufficient degree of dryness is reached. Cones of this character are best dried in a warm room. The huge, strong cones of the Gray Pine and Coulter Pine should also be dried in a warm room. Even when these cones are completely dried, the scales do not always open sufficiently to liberate the seeds. It will then be necessary to split or cut the cones in order to get the seeds out.

When the cones of Firs, Tulip-tree, and Birches are sufficiently dry, they will fall to pieces completely, forming a mass of seeds and cone scales. The quickest and most economical way of separating the seed is to sift the mixture through a wire sieve with meshes of the proper size to retain the scales and let the seeds through. A few trials will determine the right-sized mesh.

The pulpless pods of the locusts, and other species with similar fruits, yield their seeds readily when dried and flailed or whipped on a tight board floor, or a sheet laid on the ground.

The pulpy pods of the Honey Locusts and Kentucky Coffeetree should be cut or broken into pieces and macerated in a tub of water till the seeds can be washed out (see Pl. I, fig. 1). Mashing and stirring the macerated mass and washing in plenty of water will allow the loosened seeds to sink and most of the débris to float. The thick strong pods of the Coffeetree are usually partly opened by severe frosts, after which the seeds can be picked or scooped out. A thorough soaking in water also renders the pods[1] pliable, so that they can be torn open and the seeds taken out.

The fleshy fruit of the Osage Orange, Plums, Cherries, Hawthorns, and Mulberries require macerating in water until the seeds can be washed from the pulp. After the seed has been cleaned it should be spread out in a thin layer and slowly dried in the shade or in a cool, airy room.

The pulp of Cherries, Plums, and similar fruits may be removed also by macerating the fruit in water till the seed can be washed clean. The pulp of the Wild Black Cherry fruit need not be removed, but is easily dried on the seed and the latter kept without further preparation.

The thick walnut hulls are best removed as soon as the nuts are gathered. The nuts are then much less bulky. Moreover, if left on during the winter storing, the fleshy hulls become moldy, mushy, and disagreeable to the touch.

Various devices are used for "shucking" walnuts. The most rapid and efficacious method is to run the nuts through a corn sheller. Another, but slower, method is to force the fruit through an auger hole just large enough to let pass a nut of average size. A 2-inch plank is provided with four legs or blocked up flatwise about a foot high, upon which the operator sits. A nut is placed over an auger hole in the plank, a blow from a mallet or hammer forces the nut through, and the hull is cut off by the edges of the hole.

The hulls of the Shagbark, Shellbark, Mockernut, and Pignut hickories are usually removed without difficulty after the nuts begin to dry. Most of the hulls fall off in handling the nuts.

Butternuts need not be hulled, for the thin hulls dry up and add no appreciable bulk.

The Overcup and the Bur Oak, together with the Bitternut, Water Hickory, and one form of the Pignut Hickory, retain their nuts more or less firmly in cups or hulls even when severely frozen and during the more or less rough handling in gathering. The cups and hulls of these add but little to the bulk, and may also be left on with no damage to the seed. In fact, under some circumstances, the hulls prevent the thin-shelled nuts from drying out too much.

Nearly all tree seeds, including those divested of their husks or pulp, should be superficially dried, as the superfluous moisture in the green or wet hulls and seed coats is likely to cause destructive molding. The point is to dry them a little externally without affecting the vitality of the seed kernels. Such seeds as acorns, and various nuts have the kernels moist when in a growing condition, and should not be dried enough to take up this moisture, for otherwise the vitality of the kernel will be destroyed. The seeds of Maples, Boxelders, Elms, Ashes, Poplars, and Willows require very little drying, while none of the coniferous seeds will need drying beyond that given in extracting the seeds from the cones. This preliminary treatment is considered fully under the following heading:

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[1] The jelly-like greenish pulp between the seeds of this species should not be eaten. It is a violent narcotic poison.

STORING SEEDS.

Seeds which are ripe before midsummer should be sowed when gathered. Seed ripened in midsummer and fall should be stored till spring. All seeds to be stored should be attended to by November. Nuts and acorns can be stored in earth out doors, or in cold caves or cellars. Small seeds, except conifers, may be stored in boxes in thin layers between layers of sand, the boxes being buried outdoors or kept in a cold cellar. Place conifer seed in sacks and hang up in cold cellar or outbuilding. Inspect often to prevent ravages of mice, etc.

GENERAL REMARKS.

The keeping of tree seeds in such a condition that they will germinate when planted is one of the most difficult problems. Some seeds will retain their vitality for one or more seasons when stored in an ordinary grain room, while others will lose their vitality completely under such conditions in a few months, or even in a few days.

A study of nature's wasteful but successful method of carrying seeds through the winter may afford some suggestions. Moreover, the proper storing of tree seeds is closely connected with the consideration of when to plant them.

Nature sows her seeds as they are ripened—from April to March; some all at once, and others a few at a time. If not destroyed, the majority of the seeds remain buried beneath the grass or leaves and germinate the following spring, or a season later. Acorns sometimes germinate in the fall during protracted warm weather. (See Pl. I, fig. 2.) The seeds of a few trees, however—the Red and Silver Maple, River Birch, Elms (Cedar Elm excepted), Poplars, and Willows, which ripen and fall to the ground before the end of June, germinate shortly afterwards.

EARLY MATURING SEEDS.

To keep the latter class of seeds till the following spring would be almost impossible, for their very transient vitality would be destroyed by drying or molding during the hot summer months. Such seeds should be planted as soon as they are gathered.

LATE MATURING SEEDS.

We have to consider here the storing of such seeds only as ripen from late summer to fall, together with a few kinds which ripen in midsummer, but which can be safely stored till spring.

General consideration.—While some late maturing tree seeds will germinate if planted shortly after they are gathered, others will not grow until subjected to freezing, or in some cases grow more readily after they have been frozen. Others, again, endure freezing without harm, but germinate equally well if not frozen. Several kinds retain their vitality in a comparatively dry state for a number of months or years, but require one or two years' contact with the soil before they will germinate. A few others will not retain their vitality except in contact with the ground, and even then will not germinate till the second season. It is evident, therefore, that all seeds can not be properly stored under the same conditions, but that the special needs of certain kinds or classes of seeds must be carefully supplied.

In general, the essential conditions for successfully storing tree seeds are, for some a cold, moist atmosphere, and for others a cool, dry atmosphere, such as will not allow heating and molding or stimulate premature germination, either of which would be destructive of vitality.

A tabular list of desirable native trees is given on page 60–63, in which the proper storage is indicated for each kind of seed. The following detailed account of the methods of storing seeds will also be useful:

Preliminary storage.—Most tree seeds will be gathered some days or weeks before it is time to store them permanently for the winter (November). During the early fall the seeds to be wintered are best spread out for temporary storage in thin layers in some cool, airy place, such as under a north shed, in the lower story of a barn, or on the upper shelves of a dry, airy cellar. Nuts and acorns are preferably kept on an earthen floor. All should be examined from time to time to see that they are not drying out too much or heating and molding. Close attention is necessary mostly for nuts, acorns, and maple seed. Excessive drying will be detected by cutting or breaking open the seed, which, if in good condition, should be plump and moist. Any shrinking of the seed kernel indicates a drying out. If drying too much, a sprinkling of clean sand, chaff, or straw, or a light cloth cover, will check the drying. If the seeds are heating or molding, spread them out in thinner layers.

Permanent storage.—For permanent winter storage, nuts and acorns are best placed in earth out of doors, and this should be done before the ground is frozen; or for regions where the ground remains open more or less during the winter storing should be completed by the end of November.

As soon as the weather becomes cool, and before the ground is frozen, a shallow pit (3 to 6 inches deep) should be scooped out on a well-drained site, preferably on a little rise of ground to insure perfect drainage of surface water. The nuts and acorns are to be placed in this excavation, and as many shallow divisions should be made in the space as there are different kinds of seeds, in order that each kind may be kept by itself. Spread out each kind in its own place, making the layers 2 inches deep for the smaller seeds and 6 inches for the larger kinds. Cover all with 6 to 12 inches of leaves, chaff, or straw, and over this place 4 to 6 inches of earth. To prevent the earth from washing, a cover of boards, slabs, or poles should be added. The outer edges of the pit should be protected with an extra heavy layer of earth in order to exclude mice, rats, or other rodents, which are likely to discover the stores and do considerable damage. An occasional inspection of the edges will be advisable to insure safety from such attacks.

Any freezing which takes place during the winter storage will not damage the seed, but will be helpful in opening the hard shells.

If a deep, cold cave, such as can be tightly closed during winter, is available, it will be an excellent place to store nuts and acorns. They can be spread out in piles on the earthen floor and left till spring. It will be advisable, however, occasionally to examine seeds thus stored to see that they are keeping properly and are not being eaten by rodents.

With the exception of conifers, the smaller seeds could be stored in the same manner as described for large seeds, but they are best mixed or stratified, as directed below, with clean, moist sand, and stored in boxes, which can either be kept in a cold cellar or cave or sunk to the level of the ground out of doors, where a low, uniform temperature will be maintained.

If only a quart or so of small seed is to be stored, it can be mixed in three parts of sand to one of seed, placed in a sack or box, and stored in a cool cellar. Larger quantities of seed are best placed in a box, the seed being arranged in alternate layers ($\frac{1}{2}$ to 1 inch thick) and sand (2 to 3 inches deep), beginning and ending with a layer of sand. In this manner a number of different kinds can be stored in the same box. In order to avoid possible mixing, it is best to separate the different kinds of seeds by placing boards, shingles, heavy paper, or cloth between them. A board cover should be placed over the box when full. The box can then be dropped into a pit deep enough to let it down level with the ground, the spaces filled in about the box, and 6 inches or more of earth so mounded up over the top as to shed water. The box may with equal safety be stored in a cold cellar.

If, in taking out the seed in the spring, much sand is mixed with it, the latter can be removed easily by sifting. All seeds stored in sand should be planted immediately after they are taken out, for allowing them to dry will be fatal to their vitality.

Seeds of conifers and a few other seeds (Mulberry, Osage Orange, Locusts, Sycamore, Catalpas, Cherries, Hackberries, Boxelder, and Ashes) need not be mixed with sand for storing, provided they can be kept in a uniformly cold, dry atmosphere, such as that of a cellar or outbuilding. The seed may then be placed in sacks and hung up, or, if the floor is earthen, placed on a wooden shelf, to prevent the absorption of moisture; contact with a dry cement floor will not damage the seed. Seed should be examined from time to time during the winter to see that it is keeping properly.

TESTING THE VITALITY OF SEEDS.

Samples of seeds to be purchased should be tested in order to avoid receiving worthless seed. Provisional tests can be made by cutting a few seeds open and inspecting for freshness and perfection of the kernels. Absolute tests are made by sowing counted sets of seed in sand or sphagnum moss; cover seed its own depth, and keep moist. Fresh seeds germinate in from ten to thirty days.

It is often necessary to determine the vital condition of certain seeds in dry storage in order that any damaging influence in the storage may be removed. It is also of great advantage, before purchasing, to test the vitality of seeds received from irresponsible dealers and collectors. Various frauds are perpetrated, and, through the ignorance of the consumer, worthless seed may be received. Old and worthless seeds of the rarer and more expensive conifers are not infrequently sold for fresh seed or mixed with a small quantity of the latter.[1]

PROVISIONAL TEST.

The only absolutely reliable test for determining the vitality of seeds is germination. But as this requires from ten to thirty days or longer for results, it is often necessary, from lack of time, to resort to a short provisional test, which will give approximately the condition of the seed. This is accomplished quickly by cutting fifty or one hundred seeds open and observing whether the kernels are decayed, rancid, moldy, shrunken, entirely dried out, or whether they are plump, firm, and moist, as is the case with a large number of different kinds of seeds when in good condition. The seeds of Persimmons, Ashes, Locusts, and Acacias may, however, be exceedingly dry and still exhibit about the same appearance when cut open as perfectly fresh seed. To discover the exact condition of such seeds will, of course, require more experience and more careful examination than is necessary for other classes of seeds. A little close study of bony seeds known to be fresh, compared with samples known to be old, will give the necessary experience. The fresh seed has a characteristic hard but elastic firmness when cut, differing greatly from the brittle, dry condition of old or lifeless seed. The saving in detecting imperfect seed will, however, be mostly with seeds of more transient vitality than the bony seeds, which, if properly treated, are likely to prove useful even when from two to five years old.

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[1] The Department of Agriculture is now well equipped in its Seed-Testing Laboratory for testing the vitality of all seeds distributed by the Department, and also of those which are submitted for test by correspondents at large. No charge is made for testing seeds.

ABSOLUTE OR GERMINATING TESTS.

The germinating test of fresh tree seeds usually requires from ten to thirty days, or for such seeds as the Locusts, Acacias, Junipers, Hollies, Hawthorns, and Tulip-tree sixty to ninety days, or even a year, may be required. Tests are made by sowing the seed in soil, sand, powdered sphagnum moss, on damp blotting paper, between folds of moist cloth, or in porous earthenware dishes. The tests made in sand or on sphagnum moss are the most reliable, and give the highest rates of germination.

Sand, soil, and sphagnum moss tests.—The seeds to be tested are sown in rows or broadcast in shallow boxes or pans filled with sand or soil, and are covered about their own depth; the sand or soil is then kept moist till all the seeds that will do so have germinated. For testing with sphagnum moss, similar receptacles are filled preferably with sand, although earth may be used, over which one-half to one inch of powdered sphagnum is placed. The moss is moistened and the seeds sown on top. The sphagnum is to be kept moist till germination ceases.

These two methods, employing either sand alone or sphagnum and sand together, give the highest rate of germination for small seeds, especially conifers, doubtless for the reason that the moss and sand supply an even amount of moisture. Moreover, the sand cultures are least liable to attacks of the molds so common under the warm and moist conditions necessary to maintain for germinating tests.

At least 100 seeds should be used as a test for each kind, while for very thorough tests from 200 to 500 seeds should be sown, limiting each test to 100 seeds.

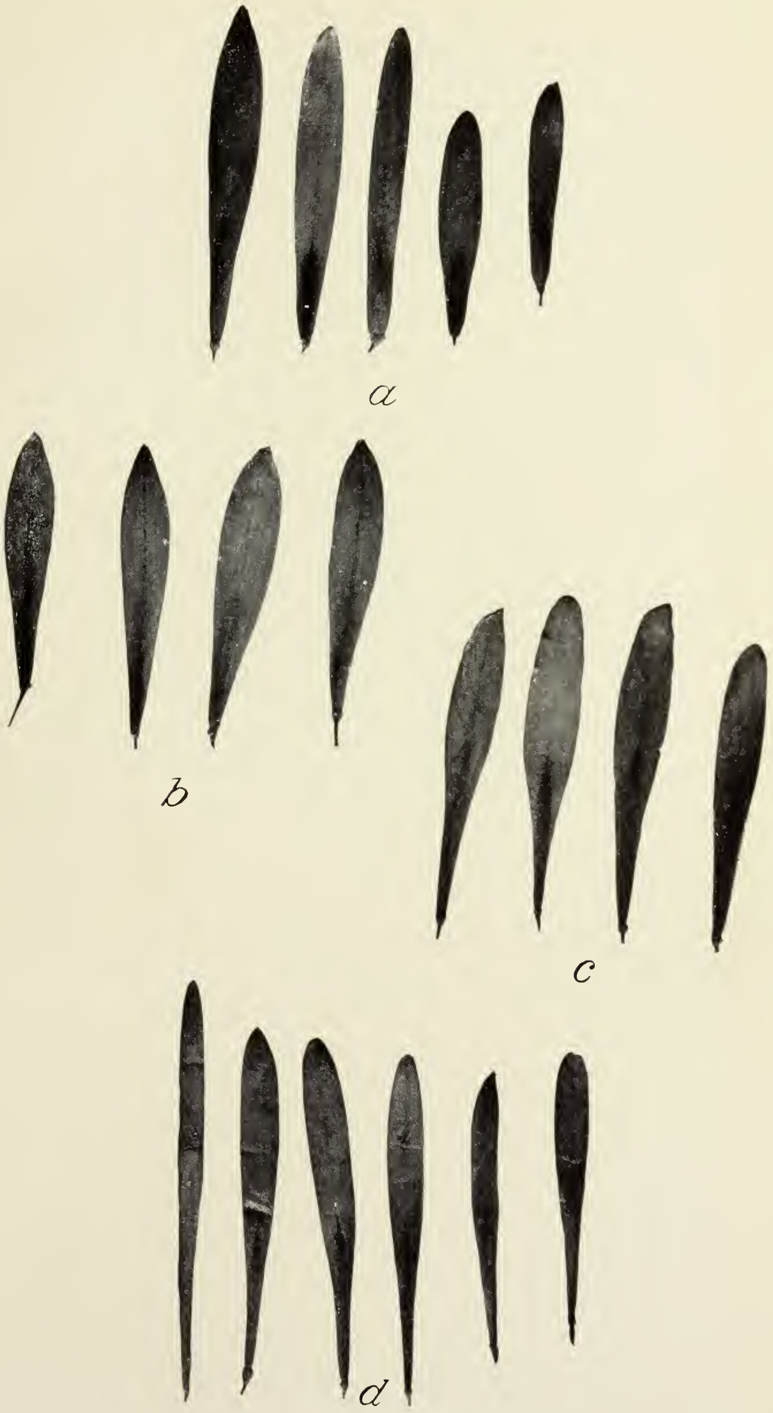
Other tests.—The testing of seeds by sowing them on constantly moist blotting paper, between the folds of moist cloth, or in porous earthenware dishes which absorb moisture, is efficacious, but not superior to the simpler and more natural methods described. The writer, at least, with other conditions unchanged, has uniformly obtained the higher rates of germination by using the sand or sphagnum tests.

Seed testing operations are usually carried on during the winter, before it is time to sow seeds out of doors. A greenhouse is an ideal place for such tests, but a room with one or more sunny windows, in which to place the seed boxes, will answer the purpose. The temperature may vary from 70° to 80° F.

IDENTITY OF TREE SEEDS.

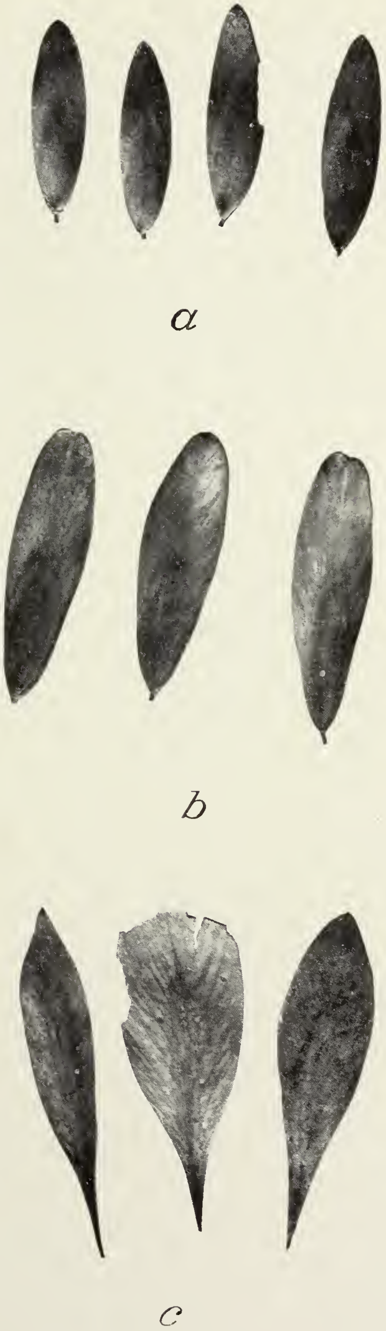
Purchased seed is often fraudulently named. When seeds are unknown or there is doubt as to their identity, planters are urged to send samples to the Department of Agriculture for identification.

The identity of tree seeds is of great importance to the planter. Either through ignorance or by intent, abundant and easily collected



Variation in size and form of seeds: *a*, White Ash seed; *b*, Oregon Ash seed; *c*, Red Ash seed; *d*, Green Ash seed. (Natural size.)

PLATE III.



COMMON VARIATION IN SIZE AND FORM OF SEEDS: *a*, BLUE ASH SEED; *b*, BLACK ASH SEED; *c*, WATER ASH SEED. (NATURAL SIZE.)

species of seeds are not infrequently substituted by dealers and professional collectors for similar but scarcer kinds; or several similar kinds may be mixed and sold for one kind. The planter may thus receive the seed of inferior trees, or of those entirely unfitted for his purpose.

Some Pine, Spruce, and Fir seeds are so similar in general appearance as to pass for the same thing. Some of the Hickories, Oaks, Ashes, Elms, Catalpas, Magnolias, Basswoods, and others are also easily confounded. (Pls. II and III). The seeds of White, Green, and Red Ash are very often mixed or one sold for the other, especially where the trees grow in the same locality. White, Black, and Red Spruce seed may be easily confounded, as also the Blue and Engelmann Spruces of the Rocky Mountains. The Blue Spruce is much the more easily collected.

The ability to recognize the various tree seeds is of course attainable only by long and careful study, such as the farmer can scarcely have time for. Those collecting, buying, or receiving tree seeds by exchange are, therefore, advised to send samples of unknown or doubtful seeds to the seed-testing laboratory of this Department, where they will be properly identified and tested without charge.

VITALITY OF TREE SEEDS.

Seeds of Maples, Elms, Ashes, Poplars, Willows, and Nuts, Acorns, etc., retain their vitality for from two weeks to six months. Those of Locusts, Acacias, and similar seeds, Alders, Tulip-tree, Hollies, and Pine seeds in cones, preserve their vitality for from seven to nine years.

Allusion has been made to the length of time for which tree seeds retain their vitality. Without considering here the conditions under which the vitality of seeds may be more or less prolonged, it may be said that certain classes of seeds have a characteristically transient, or more lasting, but gradually decreasing vitality. The seeds with the shortest duration of vitality are those of the Maples, Elms, Birches, Poplars, and Willows, some surviving only a few weeks, and others scarcely from fall to spring. The Hickory nuts, Walnuts, Butternuts, Beechnuts, Acorns, Chestnuts, and Buckeyes survive scarcely a season. Among those to retain life the longest are the seeds of Locusts, Yellow-wood, Kentucky Coffeetree, Redbud, Alders, Tulip-tree, and Hollies, but they show a decrease in vitality in from one to two years. The Pine, Spruce, and Juniper seed retain vitality about the same length of time, but if kept in their cones, some of the Pines with close cones (Lodgepole Pine, Table Mountain Pine, Pond Pine, and others) have been known to give a small per cent of germination when the seeds were 7 to 9 years old.

HIGH AND LOW GERMINATION OF SEEDS.

Nut trees, Oaks, Pines, Spruces, Junipers, Cherries, Ashes, Elms, Catalpas, etc., have 50 to 90 per cent of perfect seed. Firs, Cypresses, Maples, Lindens, Tulip-tree, etc., have 5 to 50 per cent of perfect seed.

The amount of good seed produced by trees varies for different species, and also from season to season. A knowledge of this variability is both interesting and of practical value to the planter, who will otherwise often be at a loss to account for the high or low germination of the seeds. At best some kinds of trees produce a very small per cent of perfect seed, while other kinds bear a high per cent. Barring the ravages of insects, which may often ruin large numbers of seeds before or soon after maturity, the nut-bearing trees, Oaks, Pines, Spruces, Junipers, Plums, Cherries, Ashes, Elms, Catalpas, and others, bear a high per cent of perfect seed, the range being from 50 to 90 per cent or more. Seeds of the Pines and Spruces are among the most perfect, fresh seed sometimes giving a germination of 90 to 98 per cent.

Among trees which bear a low per cent of perfect seeds are the Firs, Cypresses, Maples, Lindens, and Tulip-tree, running from 5 to 50 per cent, or sometimes more. The Tulip-tree has an exceedingly small proportion of good seed (5 to 10 per cent).

PERCENTAGE OF GERMINATION.

The following table gives the approximate range in the per cent of germination for 63 important species:

Germination of tree seeds.

Name of species.	Percentage of germination in fresh seed.	Name of species.	Percentage of germination in fresh seed.
White Pine	70 to 90	Pignut Hickory	50 to 75
Bull Pine	60 80	River Birch	65 80
Shortleaf Pine	50 75	Yellow Birch	65 80
Loblolly Pine	50 80	Sweet Birch	65 80
Pitch Pine	60 85	Beech	75 95
Scrub Pine	50 80	Chestnut	75 95
Lodgepole Pine	60 85	White Oak	75 95
Banksian Pine	75 90	Bur Oak	75 95
Longleaf Pine	50 70	Chestnut Oak	75 95
Monterey Pine	75 98	Red Oak	60 80
Tamarack	50 75	Yellow Oak	60 80
Black Spruce	60 75	Spanish Oak	60 80
Red Spruce	60 75	Slippery Elm	50 75
White Spruce	60 75	White Elm	50 75
Blue Spruce	60 75	Cork Elm	50 75
Engelmann Spruce	60 75	Hackberry	70 80
Red Fir	60 75	Red Mulberry	75 90
Hemlock	30 60	Osage Orange	60 95
Balsam Fir	30 50	Tulip-tree	5 10
White Fir	40 55	Sweet Gum	50 75
Bald Cypress	25 50	Sycamore	60 75
Incense Cedar	40 65	Black Cherry	75 80
Arborvitæ	50 75	Honey Locust	50 75
Pacific Arborvitæ	50 75	Kentucky Coffeetree	50 75
Lawson Cypress	25 40	Sugar Maple	30 50
Red Juniper	50 75	Red Maple	25 60
Walnut	75 80	Silver Maple	25 60
Butternut	75 80	Boxelder	40 60
Bitternut Hickory	70 85	White Ash	35 50
Shagbark Hickory	50 75	Red Ash	35 50
Shellbark Hickory	50 75	Green Ash	35 50
Mockernut Hickory	50 75	Catalpa	[illegible] 75

PROMPT AND SLOW GERMINATION.

Seeds with thin, weak, absorbent coverings germinate quickly; those with hard, stony coverings, or of bony consistency, germinate slowly. To hasten germination soak locust and similar bony seeds in hot water three to six days before planting.

When planted in moist, finely pulverized soil different kinds of fresh tree seeds require a comparatively longer or shorter time before they germinate. The moisture and warmth of the soil may be similar for all the seeds planted, but there will be a wide variation in the time needed for germination. Some will germinate within ten days, some in one or several months, while some others may not sprout until the second season and then often irregularly.

Other conditions being equal, the difference in the character of the seed coats and coverings, especially in their ability to quickly or tardily absorb moisture, as well as the amount of water necessary to be absorbed, must largely explain the inequalities in time of germination. The thin, easily rotted seed covering of the Maples, Elms, Birches, Ashes, Pines, and Spruces are quickly acted upon by soil moisture, and, if perfectly fresh, the seed may be expected to germinate more promptly than seed with heavier coverings. Most of the locust tree seeds and their allies have thin seed coats, but the substance of the seed is thick, dense, and horny, naturally requiring months, or even several years, of contact with the soil of average humidity before they are sufficiently permeated with moisture to grow. Similar also in the length of time required to germinate are the thick-shelled seeds of the Junipers, Hollies, and Hawthorns.

The germination of such seeds as Persimmon, Juniper, Holly, Hawthorn, etc., will be greatly hastened by placing them in vessels of warm water—at least a bucketful to one or two quarts of seed—and letting them soak for five or six days. The germination of Juniper seed may also be still more hastened by placing the water-soaked seed in lye for two days; lye made from wood ashes should be used. Soaked seed should be planted at once. The seeds of Acacias, Locusts, Kentucky Coffeetree, Redbuds, and Yellow-wood should be treated as follows before planting: Place the seed in a vessel of water heated to the boiling point and stir briskly at intervals during five to ten minutes; then leave the seeds to soak for three to four days. At the end of this time take out the seeds which are floating on the surface of the water and plant them at once in moist earth, being careful not to allow them to dry out. They will be in excellent condition and should germinate promptly. Continue scalding the sunken seeds till all have risen, promptly sowing, as before, the supply secured from each treatment. The different degrees of dryness common to seed of this class accounts for the difference in the amount of soaking required for each lot.

The seed kernels of the nut-bearing trees, and of Oaks, Junipers, and Hawthorns are unable to burst through the hard, strong shells surrounding them until the latter are thoroughly saturated with moisture and partly decayed, a process requiring, according to the character of the covering and the amount of moisture in the soil, from half of one season to two or three seasons.

PROPAGATION OF TREES FROM SEEDS AND CUTTINGS.

PROPAGATING FROM SEEDS.

Propagation of tree seeds is similar to that of garden seeds.

But little can be said concerning the sowing of tree seeds which does not apply as well to ordinary garden seeds. There is practically no difference in the care and soil necessary for the best results from either class of seeds. Given a moderately rich, gravelly or sandy, porous, moist soil, within the proper range of temperature, any tree can be propagated from the seed and made to live for a longer or shorter time.

NATURAL SEEDING.

Natural seeding is uncertain, except in loose, constantly moist soils, protected from grazing and fire.

One of the important considerations in raising tree seedlings is to produce the largest amount of good stock with the least expenditure of money, time, and labor. Nature's method of sowing seeds broadcast is too often uncertain, because the necessary conditions for germination are perfect only by chance. The Ash, Walnut, Hickory, Oak, and other trees which bear an abundance of seed in pastures or other fields are rarely surrounded by a thicket of young trees. The conditions favorable to the preservation and germination of seed on such sites are usually wanting when the seed is shed, so that it is either all destroyed or never germinates, or, if it does sprout, the tender seedlings die from exposure to wind, sun, or the trampling of stock. On the other hand, if a sufficiently soft, penetrable, and moist soil be at hand, such as may occur in a forest protected from grazing and fire, nature's sowings do well, and a multitude of Maples, Ashes, Birches, Pines, etc., cover the ground beneath or near the seed trees.

If managed by an expert forester natural seeding of cleared land from adjacent forests may often be depended on for recovering such areas with useful timber trees. Where opportunities for this kind of reproduction are favorable, natural seeding may with advantage be resorted to by the farmer also. Thus in naturally wooded hilly regions of the East protective forest covers can be cheaply and surely returned to steep unproductive slopes by natural seeding from adjoining woodland. Valuable agricultural lands at the bottom of such slopes are then protected from further dangerous washing.

But where the farmer has the definite purpose of producing useful timber without loss of time, natural seeding is not to be depended on. Direct planting of sufficiently advanced nursery stock has the advantage over natural seeding of establishing more quickly and with greater certainty only such timber trees as are wanted.

PLANTING AND SOWING SEED WITH FIELD CROPS OR ON PREPARED AND UNPREPARED GROUND.

Planting seed with cultivated crops, or sowing broadcast on prepared and unprepared land, is uncertain, giving less uniform results than planting nursery grown seedlings.

The planting of the seeds in hills or rows alternating with some hoed or cultivated field crop, or sowing broadcast with a grain crop[1] (oats, buckwheat, etc.), has been tried to some extent in the prairie region, but usually with poor results, especially with the broadcast sowing. Walnuts, Osage Orange, Green Ash, and Catalpa have succeeded fairly well when planted in alternating rows with corn and subsequently cultivated for several years.

Another similar method is to prepare the ground as thoroughly as possible by plowing and harrowing either the whole or alternating parallel strips from 1 to 6 furrows wide. The seed is then sown broadcast on the prepared land, which is harrowed to cover the seed. Stock is kept out and the sowing left to take care of itself. The seedlings are compelled to fight for a standing with weeds, grass, and all other comers. The growth of the seedlings is usually slow; many of them die in the struggle and many seeds fail to germinate.

Seed may also be sowed broadcast on unprepared land in early spring before or after the snow goes off. Sowing on bare unprepared land gives very few seedlings or, more often, entire failure, but sowing seed on snow in early spring gives much better results. Seed moistened by the melting snow is likely to germinate whenever by accident it comes into close contact with the soil, while the seed sowed directly on the ground usually fails to germinate for lack of timely and sufficient moisture.

But for the establishment of large, or even small, forest plantations, the above methods of sowing with or without crops, or planting the seeds in hills, have little to commend them over the more economical and surer method of establishing a plantation by raising seedlings in a seed bed and nursery and afterwards transplanting them to their permanent site.

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[1] In parts of France, Germany, and Russia cleared strips of government forest land are sometimes turned over to peasants for cultivation with the provision that during the last year of tenure tree seeds shall be sown with the field crop.

SEED-BED CULTURE.

Seed-bed culture requires the least labor and produces the most and best stock.

A large stock of tree seedlings can be raised in seed beds at a comparatively small cost. The perfect soil preparation necessary to the fullest germination of seed and the vigorous growth of the seedlings is easily secured on the limited area of a seed bed, whereas similar preparations for sowing seed in a large field, where the trees are to stand permanently, would require much more labor and would probably be less perfect in result. Moreover, the seedlings are thus brought through their most tender age in the seed bed, where they can receive better cultivation and protection from sun and drought.

LOCATION, SOIL, PREPARATION, AND SIZE OF THE SEED BED.

Locate the seed bed on a well-drained site. The preferable soil is a deep, sandy loam; loose gravelly soil is next best. Enrich poor soils. Plow or spade deep, and harrow or rake thoroughly.

Location of seed bed.—A site on high ground affording good surface drainage without severe washing is most suitable for a seed bed. Where possible, level ground should be chosen in place of slopes where there is likely to be too much surface washing. When necessary to locate on a slope, the gentlest one should be preferred. A port on of a well-worked field or garden is better than new ground or that long out of use.

Whether the beds should be located near the home site or near the proposed forest plantation is a question to be carefully considered from the standpoint of economy in time in reaching the beds for cultivation and for convenient access to water. Proximity to the site of the forest plantation will be advantageous for quickly transferring the seedlings by hand to the ground where the final planting is to be done. There may, however, be no convenient water supply which, in case of drought, is indispensable for the beds after the seed is sown or for the growing plants. If far from the home site, much time must also be consumed in going and coming from the beds during the period of cultivation and other attention. All points considered, it will probably be most advantageous for the average farmer to locate seed beds near home.

Where possible, seed beds are best located on the east or, preferably, on the north side of a hedge, wind-break, building, or fence for the sake of extra shelter from the sun. Seed beds may be located in open places in a forest, or outside, near an eastern or northern border. The establishment of seed beds and nurseries in and very near forests is the prevailing practice of European foresters, one of the main objects being to have the plant material near the sites of the plantations.

Soil and preparation.—Preferably the soil should be a deep, sandy loam of moderate richness. A deep, loose, gravelly soil will be favorable if the finer soil can not be had. If the soil is naturally poor it should be enriched with well-rotted manure. If the ground has been under continuous cultivation, a deep plowing or spading and thorough raking or harrowing will suffice for preparation. If the ground has been long uncultivated—pasture, meadow, or waste ground—it will be of the greatest advantage to plow or spade the site 10 to 12 inches deep the fall before the intended planting, if possible, turning under 4 to 6 inches of rotted manure. As soon as the ground can be worked in the spring it should be plowed or spaded again and thoroughly pulverized by raking or harrowing, removing all clods, stones, etc.

If this preparation seems too painstaking, it need only be said that crops are good in proportion to the amount of good tillage they receive before and after planting. No one knows this better than the successful farmer. The extra preparation of the seed bed will be amply repaid by more and better seedlings.

Size of the seed bed.—The size of the seed bed will, of course, be determined by the amount of seed to be sown. A convenient width is four feet, the length varying up to several hundred feet, or more, according to the space required. The width is important, because it determines convenience in sowing and weeding and in the use of portable screens (see p. 46). Otherwise the bed can be formed much the same as the ordinary garden bed. For large numbers of certain vigorous growing seedlings (mentioned on p. 42), it will usually be advisable to abandon this special form of seed bed, and to sow the seeds in long rows, far enough apart to allow cultivating with a horse. If hoed, long rows will also be preferable to the shorter ones.

BOX CULTURE.

An advantageous culture for a small number of seedlings and for early indoor sowings; box culture also stimulates large root growth, which is favorable to transplanting.

A modification of the seed bed is the use of shallow boxes filled with earth in which the seeds are sown. For small quantities of seeds this system has some advantages over the ordinary seed bed; principal among them is that sowing can be commenced much sooner, if desirable, as the boxes (being of convenient size) can be kept indoors during early spring, and when the weather is warm enough they can be arranged out of doors. Boxes are also of advantage in better fitting a few kinds, such as the Oaks and Hickories, to stand transplanting. If planted in the open ground, such seedlings produce large, long tap roots with few secondary roots. The effect of growing them in shallow boxes is, by refusing the roots depth, to stimulate a greater development of lateral roots. Seedlings so prepared rarely fail when transplanted.

SOWING THE SEED.

There are two methods of sowing seeds, (1) broadcast and (2) in rows; the latter is preferable as it gives stronger plants and avoids much hand weeding. Broadcast sowing gives more seedlings per foot, but the plants are weaker unless thinned, and require much hand weeding.

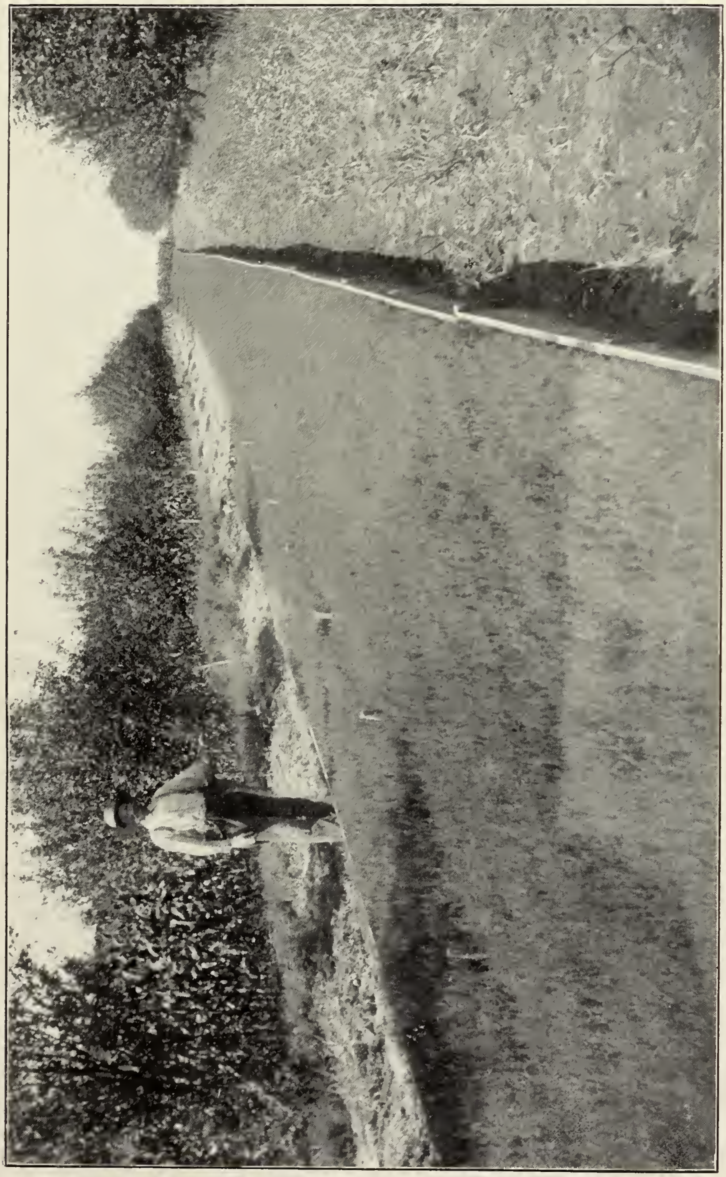
Comparison of broadcast and drill sowing.—A proportionately larger number of seedlings can be raised by sowing broadcast than in rows, and for this reason most nurserymen adopt the former method. (See Pl. IV.) Sowing in rows is preferable, however, to broadcast sowing, for the reason that most of the weeding can then be done with a hoe or other weeding tool, while the weeding when sown broadcast must be done entirely by hand.

It should be remarked that it is sometimes possible to secure so dense a stand of seedlings by broadcast sowing that many weeds will be choked or shaded out, but in general practice such conditions are difficult to establish except with thickly sown seeds of uniformly high rates of germination. The failure of certain seeds to germinate must cause openings in the bed and, therefore, opportunities for the weeds to come in. Moreover, a careful study of many seed-bed plants from broadcast sowing shows that there is a great difference between size and vigor of plants on the margins and of those in and near the center of the beds; the latter are usually slender and weak, while those on the borders are robust and strong. Seeds sown in rows produce plants of uniform size and vigor throughout the beds.

SOWING IN DRILLS OR ROWS.

Sow seed of conifers, Birches, Cherries, Elms, hard Maples, Ashes, Hackberry, etc., in rows 8 to 12 inches apart for hand cultivating; sow nuts, acorns, and seed of soft Maples, Catalpas, Locusts, etc., in plain rows 3½ feet apart for horse cultivating, or 2 feet apart for hand cultivating.

It is recommended that all seeds be sown in rows, both to facilitate weeding and also to give an opportunity easily to cultivate the soil about the plants. The latter is especially advantageous to plants in dry weather, preventing rapid evaporation from the soil. The seeds which produce comparatively small seedlings the first year, such as conifers, Birch, Cherry, Elm, hard Maple, and Hackberry, can be sown in small beds, similar to those for garden plants, and in rows 8 to 12 inches apart. The bulkier and more rapid-growing seedlings of soft Maples, Hickories, Walnuts, Catalpas, Oaks, and Locusts, except for very small quantities (when a small bed will answer), must have more space between the rows. The form of the seed bed may then have no likeness to the ordinary raised garden bed, but will be in the nature of a nursery plat, in which the seed is sown in rows 3 to 3½ feet apart, so as to allow the easy passage of a small horse cultivator, or 2 feet apart if cultivated by hand.



ROCKY MOUNTAIN JUNIPER SEEDLINGS, 2 YEARS OLD, 8 TO 18 INCHES HIGH. ONE-EIGHTH OF AN ACRE OF SEED BED, CONTAINING 1,000,000 PLANTS, AND SHOWING AN EXCEPTIONALLY DENSE STAND FROM BROADCAST SOWING.

[Propagated by W. H. Bruning, Cedarbluffs, Nebr.]

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It is important to impress upon the planter at this juncture that all seeds stored for the winter in earth or sand should be sown at once after they are uncovered, or so protected till sown that they will not be dried out in the least. The partial drying out of such moist seed may be fatal to its vitality. Seed kept for the winter in dry, cool storage is also better for being promptly sown after it is removed from its storage.

Thick and thin sowing.—The proper spacing of seed in the row is important in economy of seed and in the production, from the first, of the most vigorous plants. If seed of a high rate of germination is carelessly and thickly sown, the result is a much too crowded stand of seedlings, which must be thinned out at an early age to prevent a weakened growth. The plants taken out can rarely be saved by transplanting them, and will, therefore, be wasted. In the case of expensive conifer seeds, it is especially urgent that the sowing be done economically.

In practice it is very difficult and slow work to sow tree seeds so that the seedlings will not require thinning. This is especially true of such light seeds as those of Arborvitæs, Incense Cedar, Cypresses, Elms, Birches, Catalpas, and the smaller Pine, Spruce, Fir, Hemlock, and Larch seeds from which the wings have not been removed. The winged seeds of Ashes, Maples, and Tulip-tree are also troublesome. Above all, high winds will often try the sower's patience by blowing the seeds about, and at times prevent him from sowing light seeds, except with great waste. The heavier, grain-like seeds, nuts, and acorns will be more easily managed.

Spacing seeds in the row.—Excepting the nuts and acorns, seeds with a maximum vitality of over 50 per cent in the table on p. 36 should be spaced at about 1 to 1½ inches in the row, while seeds with a maximum percentage of germination lower than 50 may be strewn so that the grains either touch each other or are spaced from about one-fourth to one-half an inch. Seed of the Tulip-tree, which has a very low per cent of germination, should be sown thickly—three or four seeds deep—in order to secure a well-spaced stand of seedlings.

The breadth of the drill or seed row may vary from a single line of plants to a row 1 inch broad. Hickory nuts, walnuts, acorns, chestnuts, and beechnuts may be planted from 2 to 4 inches apart in a single line. Nurserymen frequently make seed rows from 2 to 6 inches wide, thus greatly increasing the number of plants raised per row. It is believed, however, that the narrower seed row will be more satisfactory for home practice.

Table showing the number of tree seeds per ounce and pound, and also the approximate number of linear feet of seed drill covered by each quantity.

Name of species.	Number of seeds in 1 ounce.	Number of seeds in 1 pound.	Approximate number of linear feet of seed-drill covered by 1 ounce.	Approximate number of linear feet of seed drill covered by 1 pound.
White Pine	1,800	28,800	36	576
Red Pine	4,760	76,160	75	1,200
Shortleaf Pine	4,990	79,840	80	1,280
Bull Pine	100	1,600	16	256
Scotch Pine	2,430	38,880	60	960
Norway Spruce	5,260	84,160	75	1,200
Red Fir	4,200	67,200	60	960
White Fir	610	9,760	10	160
Bald Cypress[1]	320	5,120	20	320
Red Juniper	1,310	20,960	40	640
Incense Cedar	1,260	20,160	35	560
Lawson Cypress	6,400	102,400	40	640
Butternut	1 (+)	16	....	4
Black Walnut	2 (−)	30	....	8
Shellbark Hickory	5	80	....	14
Chestnut	6	98	....	17
Black Locust	1,810	28,960	60	960
Honey Locust	200	3,200	16	256
Hardy Catalpa	1,230	19,680	60	960
Osage Orange	820	13,120	30	480
Green Ash	1,020	16,320	25	400
White Ash	640	10,200	25	400
Black Ash	380	6,100	18	288
Boxelder	920	14,720	26	416
Sugar Maple	470	7,498	20	320
Scarlet Maple	140	21,980	50	800
Black Cherry	279	4,464	20	320
Basswood	397	6,352	15	240
American Elm	5,820	93,120	125	2,000
Slippery Elm	3,398	54,368	80	1,280
Birch[2]	30,116	481,856	750	12,000

[1] About 50 per cent of the bulk of Cypress seed in the trade consists of refuse shells of cones.
[2] Includes principal Eastern species.

Marking seed rows.—For smaller seeds the preparing of seed drills in which to sow tree seeds is not different from that practiced in sowing ordinary garden seeds in drilled beds. Parallel drills can be made by running a stick or hoe handle along the straight edge of a board long enough to span the bed. The sowing and covering of the seed is then done by walking on the board to avoid trampling the soil. Longer seed rows and those for nuts and acorns can be marked with a stick or pointed hoe along a garden line; or the ground can be marked off in parallel rows with a temporary marker like those used for marking corn ground. The track of the marker will usually form a drill deep enough to receive the seed.

WHEN TO SOW.

Sow seed from April to middle of May, when the soil is moderately moist, not when wet nor very dry.

The time to sow seeds will vary with the region. In general this is as soon in the spring as the soil is dry enough to be worked. For the northern and middle United States this will be from the 1st of April to about the 20th of May. For the southern States sowing may be done in February and March. Seeds are best sown when the soil is moist, never when wet or entirely dry. If the soil is wet and remains so, the seeds are liable to rot before they germinate; and if very dry they are likely to lose much time in late germination or to "lie over" till another season.

COVERING SEEDS IN THE SEED BED.

Cover small seeds two or three times their own depth; cover large seeds about twice their depth. Firm the earth over the seed rows by rolling, pressing down with a board, or patting with the back of a hoe or spade.

The proper covering of seeds when sowed is an important consideration. If the cover is too shallow the seeds may be washed out, and if too deep they may rot, or the plants may not push through the heavy cover, or the seeds may even lie buried in a living half-germinated state till another season.[1]

A safe rule for covering all small seeds is at least twice and not more than three times their own depth; large seeds may be covered about twice their depth. Seeds will germinate much better and are less likely to be washed out if after sowing the soil be firmed by running a light roller over the entire bed, or if the earth over the seed row be gently tapped with the back of a hoe or pressed with a board.

MOISTURE IN SEED BEDS.

The soil should contain enough moisture to give an even freshness. For conserving this moisture place a 2-inch cover of chaff or straw over the bed until the seedlings begin to appear, when the covering should be removed.

An even supply of moisture in the soil gives the highest rate of germination for all seeds and in the shortest time. The proper amount of moisture is also of equal importance. Damage will as often be done by too much water as by allowing the soil to become dry and baked; the essential point is to maintain enough moisture in the soil to give freshness and looseness. A sprinkling of 1 to 2 inches of dry wheat chaff over the seed bed will hold the natural moisture of the soil for a long time. If watering becomes necessary, the covering will prevent undue packing and washing of the soil by allowing the water to percolate into the soil gradually.

A close watch should be kept upon the beds, and as soon as the seedlings begin to, break through the ground the covering must be removed.

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[1] The writer has seen Black Walnuts planted at a depth of 6 to 12 inches germinating the second season. It is possible for many other kinds of seeds, when buried at a depth of 6 inches to several feet, to retain their vitality for from one to ten or more years.

SHADING SEEDLINGS.

Shade conifer seedlings during the first two seasons and broadleaf seedlings during the first season.

General remarks.—Many broadleaf seedlings, such as Catalpas, Locusts, Ashes, Boxelder, Maples, etc., will endure exposure to the hot sun during their tender early growth, but almost all tree seedlings are better with a light protection until they have become hardened. A few of the conifers also endure early exposure, yet shade is very beneficial to these plants during the first season; in fact, for some of the tender kinds shade is absolutely necessary for success.

Making screens.—Shade may be variously and cheaply supplied by lath screens the size of the whole bed, or preferably by several screens of such convenient size that combined they will cover the bed. Screens are made by nailing lath of full length on two end rails (1 to 2 inches thick and 4 to 5 feet long), spacing the lath about 1½ inches. For shading the beds, the screens should be supported 18 to 24 inches above the ground; 18 inches is high enough for all conifers and 24 inches is about right for all other seedlings.

This is done by driving a line of small posts into the ground on the two long sides of the bed, the distance from post to post across the bed being right to catch the ends of a screen. These posts are placed at intervals of 4 to 5 feet apart in the line, and, according to the class of plants to be shaded, the tops of the posts are left at a height of 18 to 24 inches above ground. Slats (1 to 2 inches wide) then may be nailed along the tops of each line of posts to form a convenient support for the screens, which are laid side by side, resting their ends on these slats; but preferably each screen may be simply rested on four corner posts. This will give free access to the beds for cultivation.

Slat screens may also be made by weaving lath together, at the proper distance apart, with three to four strands of small fence or baling wire, in the same manner as in making a slat-and-wire fence. Two anchor posts are used for this weaving. The long strips of screen woven can be cut into convenient short lengths, or used of any length sufficient to cover one long bed. Long screens are put on or taken off the beds by unrolling and rolling the screen.

An effective screen is made by stretching a cheap muslin on convenient-sized frames. This screen affords complete protection with a strong diffused light, but is likely to be troublesome in case of high winds, when the slat screen is preferable.

The practice of nurserymen is not uniform in the height at which screens are supported above the seed bed. Some place the screens at from 1 to 2 feet above the bed, while others hold that a height of 4 to 5 feet is preferable. The use of high screens permits cultivation of the beds without removing the screens, and also gives a somewhat freer circulation of air over the beds than the low screens. The latter have to be taken off when the beds are cultivated. Another advantage of the high screen over the low one is that often the former may be very inexpensively constructed by laying leafy branches or brush over supporting poles. Such a screen need not be disturbed during cultivation, while a low screen so constructed could not be handily removed to permit cultivation.

Beds covered with high-roofed screens will need screening on the eastern, southern, and western sides, in order to protect the outside plants from being scorched. Side protection also of seed beds covered with low screens will be advantageous for Western regions, especially on sides toward the prevailing hot winds. Otherwise severe and rapid drying out of the seed bed may take place.

In conclusion it may be said that seedlings are grown with equal success under both the high and low form of screen, so that the planter may choose either.

How long seedlings should be shaded.—For conifers the screens may be advantageously kept over the seed beds from the time the seeds are sowed till the fall of the second season, setting the screens aside only on cloudy days or during gentle rains. In case, however, previous to an expected rain, the soil is already sufficiently moist (and very close attention should be given to this point), the screens may be left on as a partial protection against excessive wetting of the soil. For this purpose one side of the screens should be raised so as to allow the water to run off quickly. If much rain falls during the first four to six weeks after the seedlings are up, a temporary but tight cover of boards should be placed over the beds in order to positively prevent any further wetting of the soil, for if continuous heavy rains are allowed to soak the beds, interspersed or followed by several hot or even warm days, very destructive "damping off"[1] is almost sure to follow. Rapid surface drainage should be arranged to carry water away from the beds as it runs from the covers.

Most broadleaf seedlings will not require continuous shading after the first two or possibly three months, for they are little affected by the sun after their second leaves have appeared. Following this period, if the weather is moderate, the seedlings can be "hardened off" for several days by leaving them unprotected, except during the hottest part of the day, or during protracted hot, dry weather, when they should be shaded.

With seed beds located on the north side of a high building or screen of shade trees, it is possible to raise broadleaf seedlings without screens at all. Conifer seedlings can also be successfully raised without screens by making the beds in the shade of a grove of trees.

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[1] See page 49.

WATERING SEEDLINGS.

Keep the soil evenly moist to a depth of at least 6 inches. Apply water to the beds gently and let it soak into the soil slowly and deeply.

The necessity of an even supply of moisture in the seed bed before the seeds have germinated has already been pointed out. The same is true after germination, conifers, as a rule, requiring less water than broadleaf kinds. If rain does not furnish enough moisture, the beds should be watered once or twice a week, and sufficiently to saturate the earth at least half a foot down. A mere sprinkling of the surface during very dry weather will avail nothing. Watering should not be done spasmodically, but promptly whenever the soil moisture begins to fail, for the growth of seedlings will be checked and injured by alternate wetting and drying. Early morning or toward sundown is a good time to water.

A good way to apply water is in shallow runways between the rows of seedlings, connecting the runways with each other at the ends of the rows, so that the water poured or allowed to run in gently may stand between rows and soak down. The bed will thus be saturated without compacting the soil. The facilities of the planter for applying water to seed beds will of course vary. Most farmers in the East will have to carry, haul, or conduct water from a well, cistern, pond, or stream, while farmers in the West may more easily supply water to seed beds from reservoirs or irrigation ditches. As previously advised, it will be well to locate the seed beds and nursery as near as possible to the water supply.

CULTIVATION OF SEEDLINGS IN THE SEED BED.

Cultivate often to subdue weeds, stimulate growth, and prevent evaporation of soil moisture.

Weeds should be promptly removed from the seed bed, for by neglecting to do this the vigor of seedlings may be greatly impaired. As soon as the seedlings are well up the soil should be gently cultivated between the rows. This will stimulate the growth of the plants and check rapid evaporation of soil moisture. For small beds cultivating can be done with a hoe or similar tool, while for the more extensive sowings in wider rows it can be conveniently done by a horse with some form of small cultivator. Frequent working among the seedlings should be continued throughout the summer and will be profitable if done oftener than is necessary to keep down the weeds. This is especially true if the weather is hot and dry.

The following table furnishes information as to the rate of growth for the first year of several species of trees under cultivation:

Approximate height of 1-year-old seedlings in cultivation.

Name of species.	Approximate height in inches.	Name of species.	Approximate height in inches.
White Pine	2½ to 3½	White Ash	6 to 10+
Red Pine	2 3	Green Ash	6 10+
Bull Pine	2½ 4	Red Ash	6 10+
Scotch Pine	2 4	Black Ash	6 10+
Banksian Pine	2½ 3½	Blue Ash	6 10+
Tamarack	2 3	Black Walnut	10 14
White Spruce	1½ 2½	Butternut	10 14
Black Spruce	1½ 2½	Shellbark Hickory	6 9
Red Spruce	1½ 2½	Mockernut Hickory	6 9
Blue Spruce	1½ 3	Pignut Hickory	6 9
Engelmann Spruce	2 3½	American Elm	5 10+
Red Fir	3 4½	Cork Elm	5 10+
Hemlock	2 3½	Winged Elm	5 10+
Western Hemlock	2 3½	Slippery Elm	10 18+
White Fir	1½ 2½	Hackberry	6 12
Arborvitæ	1½ 2½	Red Mulberry	8 10+
Giant Arborvitæ	1½ 2½	Russian Mulberry	8 10+
Incense Cedar	2 3	Black Locust	18 20+
Lawson Cypress	1½ 2½	Honey Locust	6 14
Red Juniper	2 3½	Kentucky Coffeetree	6 12+
White Oak	5 9	Paper Birch	3 8+
Chestnut Oak	5 9	Yellow Birch	3 8+
Post Oak	5 9	Sweet Birch	3 8+
Burr Oak	5 9	Black Cherry	8 14
Cow Oak	5 9	Sugar Maple	6 12+
Red Oak	6 12+	Red Maple	6 10
Black Oak	6 12+	Silver Maple	12 20+
Scarlet Oak	6 12+	Boxelder	10 14
Pin Oak	6 12+	Basswood	6 12
Water Oak	6 12+	Hardy Catalpa	14 20+

"DAMPING OFF."

"Damping off" is a fungous disease destructive to very young seedlings. Avoid it by preventing excessive moisture in seed beds soon after the seedlings come up, especially in hot weather. Prevention is aided also by thin sowing, frequent cultivation, allowing free circulation of air among seedlings, and by sprinkling one-fourth to one-half an inch of dry warm sand over the bed.

The destructive malady known as "damping off" attacks tree seedlings during their early tender growth. It is manifested by a sudden wilting and dying of large numbers of plants without apparent cause. The disease is most prevalent among conifers, but young broadleaf seedlings also are sometimes affected. It is caused by a fungus, the growth of which is promoted by excessive moisture in the soil, accompanied by hot, murky weather. The presence of such conditions during the critical period—usually the first two or three weeks of growth—may result in the wilting and dying of thousands of seedlings in a single day. There is no help for the wilting plants, but those still unaffected may sometimes be saved by drying out the soil in the beds. Allowing free circulation of air by elevating the screens and lifting them entirely when the sun is off and sprinkling dry, warmed soil or sand around the plants will often check the disease. Preventive measures are, however, likely to be more effectual than local treatment, for, when the disease is once started, there are times when no amount of drying will check the destruction.

As preventives against damping off, thin sowing is recommended for conifers, together with special means of protecting the beds from being soaked by heavy rains. Provision for quickly draining the water from around the bed is also very important. It is best during wet and hot murky weather to keep the soil rather dry and to cultivate frequently.

PROPAGATING TREES FROM CUTTINGS.

Grow willows and poplars from cuttings rather than from seed.

Many broadleaf trees can be grown from cuttings made from branches or sprouts. A few conifers also have been grown from cuttings and from the layered branches of trees. A low branch is bent down and a part buried in the ground till it takes root, when it is cut off. But, for the practical purposes of the forest planter, this method of propagating conifers is too slow and uncertain. The growing of poplars and willows from cuttings is thoroughly practical, and will often be a convenient means of propagating these trees, especially when seeds or seedlings are not available.

The seeds of willows and poplars are comparatively difficult to collect and troublesome to handle in sowing, while the cuttings of these trees are easy to manage.

MAKING CUTTINGS.

In general, willow and poplar cuttings can be made from any time after the fall of the leaves to just before spring growth begins. A good time to make them is in February or March. Cuttings from branches or sprouts of willow and poplar of almost any thickness will grow if placed in the ground; but fully matured 1 or 2-year-old parts of branches (one-fourth to one-half an inch in diameter) will give the liveliest cuttings.

A convenient length for cuttings is from 8 to 12 inches. In making them it is preferable to cut the twigs off square with a thin-bladed hatchet, ax, or, better, with hand pruning shears.

For convenience in handling, cuttings may be tied in bundles of 50 to 100 or more, and if, as they are cut, the top ends are placed one way, no sorting will be needed in setting. To prevent the cuttings from drying out, the bundles should be buried in moist sand or earth till wanted for planting. The covering of sand or earth should be at least 1 foot deep to insure keeping the cuttings moist. Freezing will not injure them.

SETTING CUTTINGS.

Cuttings should be set in the spring. The ground selected for them and its preparation may be the same as that for seeds. If a large number of cuttings are to be set, they should be planted 6 inches apart in rows 3½ feet apart, which will give room for a horse cultivator. A small number of cuttings may be set in rows 2 feet apart and hoed. The growth of cuttings is usually vigorous and more space is needed between rows than for most seedlings of the same age.

Cuttings may be set slantwise or upright in the ground, bottom or larger end down, leaving about 2 inches above ground. Cuttings set slantwise allow the earth to settle better and also to be firmed more closely about the cuttings than when set upright. Close packing of the earth is very important, and for this reason setting the cuttings slantwise is preferable.

To facilitate the planting, a trench may be dug or plowed out in which to set the cuttings. The cuttings are stuck upright in the bottom of the trench, or, if to be set slantwise, laid down along one side, filling in and tamping the earth firmly about them in the manner of planting a tree. Cuttings may also be set in a narrow deep slit made by sinking a spade into the soil, slantwise or vertically, and simply prying the earth apart two or three inches. After putting the cuttings in place, loose earth can be hoed into the slit and firmed about the cuttings by the foot or tamping block. Usually the slit can be properly closed by tamping each side with the foot or block.

Cuttings may also be quickly and successfully planted by simply pushing them into the soil to the proper depth and afterwards tamping the earth firmly about each cutting.

The care and cultivation of cuttings should be the same as for seedlings.

While the preceding remarks apply to cuttings in general, those of the Willows, Poplars, and Artemisias may be set at once in their permanent sites, for their growth is so vigorous as to make them very bulky to transplant if allowed to take root and stand one year in the nursery.

WINTERING AND TRANSPLANTING SEEDLINGS.

WINTERING SEED-BED STOCK.

Protect seed bed before the ground freezes by banking the rows with earth and covering with 3 inches of straw for warm climates and a foot or more for cold climates.

Some protection is necessary, or at least beneficial, in wintering seedlings in their first season. Such preparations should be made just before the ground freezes, or, for mild climates, at the beginning of cold weather.

In regions where the winters are mild and the ground is only slightly frozen, very little winter protection is needed for the seed bed. For broadleaf kinds, a slight "hilling up" of the earth against the row of seedlings to a depth of not over 6 inches will suffice. The trenches thus made between the rows should be shaped so as to carry off all surface water. For conifers, the hilling should just reach the foliage.

Two or 3 inches of straw may be sprinkled over the beds, with branches laid on top to prevent the straw from being blown off. The straw will prevent sun scorching, which is likely to occur toward spring.

Where the winters are severe the seedlings should have, in addition to the banking of the earth, a foot of straw spread over the top and held down by branches or poles.

Chaff, leaves, or moss can be used for protection in place of straw, but the latter is preferable, because it can be much more easily removed in the spring.

TRANSPLANTING SEED-BED STOCK TO THE NURSERY.

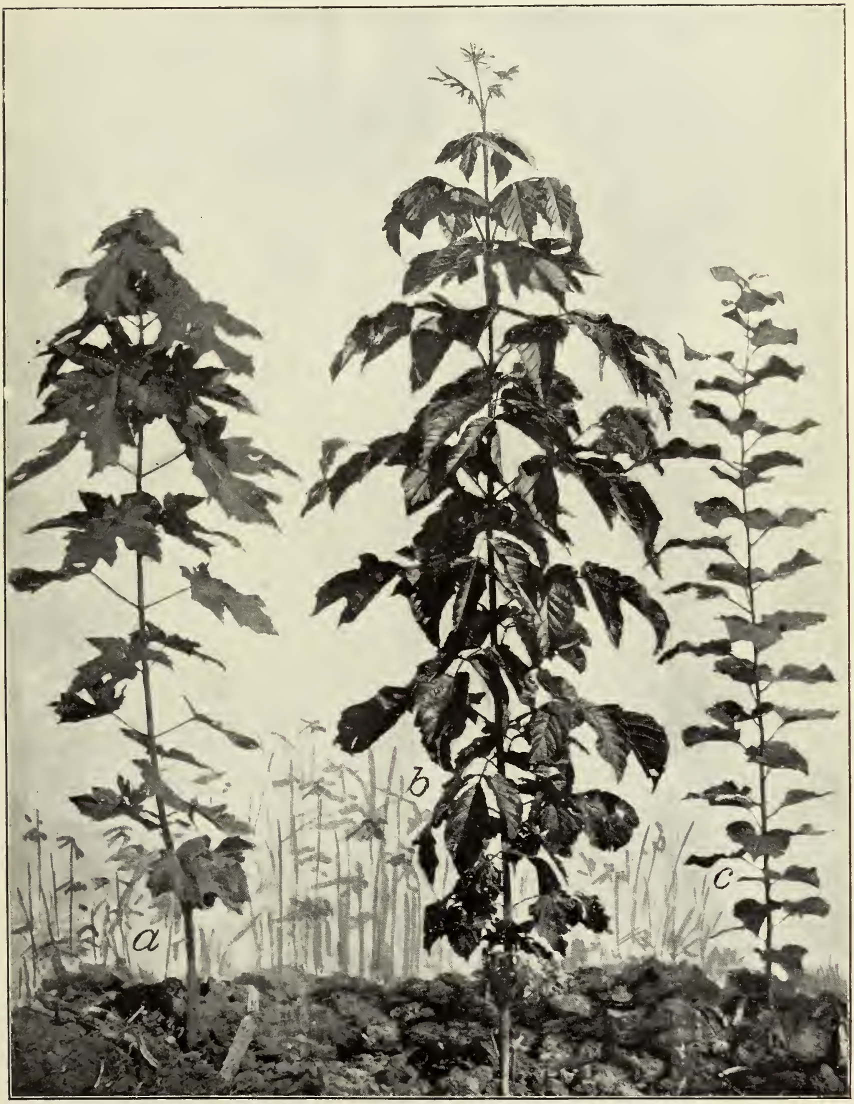
Transplanting increases root growth and thus produces vigorous plants. Transfer such fast-growing 1-year-old stock as Walnuts, Catalpas, Locusts, soft Maples, to nursery rows for a year. Slower growing broadleaf trees and conifers may remain in the seed bed two seasons; then transplant to the nursery for one year, or transplant from the seed bed at 1 year old and grow in the nursery for two seasons.

GENERAL CONSIDERATIONS.

Vigorous root development is produced by transplanting yearling seedlings from the seed bed to nursery rows. The disturbance of the roots in shifting the plants from one site to another, and also the allowance of more room in the nursery, stimulates the growth of small roots. Such plants are markedly more vigorous than those of the same age not transplanted, and therefore establish themselves better when permanently set out. Seedlings taken from the forest are also much improved in vigor by transplanting in the nursery for one or two years.

Instead of transplanting all the plants in a seed bed some nurserymen take out only a part of them. Those left in the seed bed are thus given room enough to grow freely till sufficiently large for permanent planting. This method of thinning is applied with some advantage to beds with large numbers of seedlings in dense stand. The saving lies in reducing the cost of transplanting all the seed-bed stock, but the stimulated root growth which follows transplanting is lost to the plants left in the seed bed, which are thus inferior to seedlings transplanted once or twice.

The slow or rapid growth of various kinds of seedlings during the first two or three years may determine the length of time seedlings should stand in the seed bed, as well as that necessary for nursery training. The slow growth of conifers makes it possible to leave them in the seed bed two years, afterwards transplanting them to the nursery for one or more seasons. If 1-year-old conifers are transplanted from the seed bed it is advisable to give them about two years in the nursery (see figs. 2 and 8). As a rule, broadleaf seedlings grow much more rapidly and need less time in the nursery. Walnuts, soft



SEEDLINGS: *a*, SILVER MAPLE SEEDLING, 2 YEARS OLD, 36 INCHES HIGH, IN PERMANENT PLANTATION, NEBRASKA; *b*, BOXELDER SEEDLING, 2 YEARS OLD, 36 INCHES HIGH, IN PERMANENT PLANTATION, COLORADO; *c*, ASPEN SEEDLING, 2 YEARS OLD, 35 INCHES HIGH, IN PERMANENT PLANTATION, UTAH.

Maples, Catalpas, Locusts, Coffeetree, and others, may attain sufficient size and vigor to be fit for final planting even at the end of the first season in the seed bed (especially if they have had plenty of room and frequent cultivation), but they are better for one year in the nursery. (See Pl. V.) Among the broadleaf species which usually grow more slowly for the first season are the Birches, hard Maples, Ashes, Cherries, Hackberries, Oaks, native Mulberries, and Elms, and they should therefore remain in the nursery for one or two seasons before final planting.

It should be added that the growth of seedlings of the same kind in different soils is so variable that it is difficult to state the exact amount of nursery treatment required to fit all seedlings for final planting. Thus in a poor soil an ash seedling may be none too far advanced after two years in the nursery, while in a richer, freer, and moister soil one year in the nursery may suffice. As a rule, however, it is advisable to give the rapid-growing, broadleaf kinds one year and the slower ones two years in the nursery rows.

ROOT PRUNING.

Judicious pruning stimulates the growth of side roots and gives vigor to the plant. Seedling Oaks, Walnuts, and Catalpas form long, fleshy taproots during the first season with but few lateral roots. This form of root is very troublesome to plant. Before setting such plants in the nursery from one-fourth to one-third of the root should be clipped off. Any other long, straggling roots of seedlings are best cut off. Seedlings with a bunch of short, fibrous roots need no cutting.

One-year-old cuttings have no taproots, but very long side roots will need shortening.

FALL AND SPRING TRANSPLANTING.

Fall transplanting is desirable only for warm regions; spring transplanting is best for cold climates.

Both fall and spring planting have their adherents. Each method is successful in the hands of professionals. The amount of time available, however, for such work in spring or fall may partly decide the adoption of one or the other method. The region will also have an important bearing. For example, in climates where the fall season is long, mild, and gradually merges into winter fall transplanting may be safely attempted. The young trees will make considerable root growth before winter, and thus gain an earlier start in the spring. But in regions where the fall season is short, cold, and abrupt fall transplanting would be hazardous and uncertain. The lack of sufficient fall root growth, coupled with the danger of "heaving," is likely to give bad results. The seedlings are much safer properly protected in the seed bed.

Many failures in fall transplanting are, however, due largely to setting the trees too late—often just before the ground is frozen or when it is wet and cold.

The planter is recommended to transplant in the fall wherever the region is favorable. Otherwise spring planting will be more desirable.

FALL TRANSPLANTING.

Fall transplanting can be done as soon as the summer's growth is over, a time which is indicated for broadleaf trees by the change of color and shriveling or falling of the leaves. The right time for transplanting coniferous plants will be indicated by the presence of a perfectly formed winter bud at the end of the season's growth.

Fall and spring transplanting are not different, so that the directions further on for spring transplanting will serve also for fall.

TAKING UP SEEDLINGS.

Success in handling seedlings depends largely upon the care with which they are taken up. The seedlings taken up with the least injury will recover most readily after setting. The preferable method is gently to raise several seedlings by sinking a spade deep into the soil 5 or 6 inches to one side of the plants and then prying up. They can then be gently pulled out and freed from the loosened earth. A much less desirable method is to pull a handful of seedlings at a time without loosening the earth. If the soil is very loose, a careful operator can lift the plants without very much injury to the roots; but if the soil is hard, great injury follows. Seedlings are pulled in this manner by grasping a bunch of stems close to the ground, and giving a steady, gentle pull till the bunch is lifted.

TRANSPORTING STOCK FROM SEED BED TO NURSERY.

After seed-bed stock has been taken up, it must usually be transported some distance for planting in the nursery or plantation. It is very important that this be done with care. Uprooted seedlings of all kinds suffer more or less when exposed to wind and sun. Conifers may be ruined by a few moments' exposure, while such seedlings as Poplars, Willows, and Mulberries may endure several days of drying and recover when planted. It is best, however, to give them all protection against drying out, thus saving even the hardiest kinds an unnecessary shock.

As the seedlings are being dug or pulled they should be laid, roots together, in separate piles of one to several hundred, or in one long pile, and the roots immediately covered to keep them perfectly moist. This can be done with a wet blanket, or with carpet, burlap, or bags, but a few shovelfuls of fresh earth is an excellent protection and is easily applied. From 6 to 10 inches should be put on the roots to prevent drying out.

Equal care should be taken to have the newly lifted stock thoroughly covered when transporting it to the nursery. If the seedlings are to be carried only a short distance, they are best packed, root ends together, lying on their sides on a layer of wet straw, chaff, cloth, or earth, in boxes, or in a tight wagon box. A cover of wet chaff, straw, cloth, etc., should then be thrown over all during transit. If the seedlings are to be hauled or shipped some distance by rail, they can be similarly packed in boxes, placing wet moss at the roots between every 6-inch layer of plants. The root ends should be tightly packed, pressed down, and held there by nailing inch-thick slats (3 to 6 inches wide) across the roots of each tier of plants; the slats may be securely held down by cleats nailed above each end to the inside of the box. The top of the box should be loosely slatted to give air.

The ingenuity of the planter will suggest other simple and effective methods of packing. The essential requirements of all packing are to hold the roots firmly together in wet moss to preserve their freshness, and to prevent bruising or other injury to the tops.

SPRING TRANSPLANTING.

As soon as the soil is dry enough to be worked, a piece of ground should be prepared for a nursery. The same situation, soil, and preparation are necessary as for seed beds. When prepared the ground is marked off in parallel rows one way. For hand cultivation, the rows containing conifers should be 1 foot apart, and for broadleaf trees 2 feet apart. For cultivating with a horse, the width of rows may be 3½ to 4 feet. When the plants are ready to set, trenches are hoed, dug, or plowed out, corresponding with the rows marked off, in which to set the seedlings. The trenches should be from 6 to 10 inches deep, according to the size of the plants. The planter must decide this, keeping in mind the general fact that the plants are to be set 1 to 2 inches deeper than they grew. In poor shallow soils the richer top earth should be kept separate for filling in about the roots; in deep rich soil this precaution will be unnecessary.

In case the soil is very dry to the depth of the trenches prepared, it will be of great advantage to water the trenches before setting the plants.

Conifer seedlings one to two years old may be set 4 inches apart in the row, and broadleaf plants of the same age about 6 inches apart.

If, in taking up and carrying the seedlings from the seed bed to the nursery, the roots have been kept moist, the plants may be set at once without further preparation. To insure having the roots perfectly moist when planted, however, which is most essential to successful transplanting, the seedling roots should be dipped in a mud bath.

The latter is prepared as follows: Make three-fourths of a bucketful of thinnish puddle by mixing water and earth—light, loamy earth or muck is preferable. Stir the puddle thoroughly and plunge as large a bunch of seedling roots down into the mixture as the bucket will accommodate. Souse the bunch several times to coat thoroughly all the roots. The seedlings are now ready for transplanting. The bucket is a convenient means of carrying the plants along the nursery row where, one by one, they are dropped in place.

Having previously marked and prepared the nursery-row trenches, as already described, the transplanting may proceed as below. Speed in all the steps is of the greatest importance to success. A clean-cut plan must be followed throughout, with no delay whatever in operations when the roots are exposed.

The plants will, of course, be set rapidly or slowly according to the number of men available. Two men, one to puddle, carry, and place the seedlings, and the other to plant, can make good headway. The addition of two men or clever boys to the crew, to puddle, carry, and place the seedlings, would increase the speed of planting greatly. The two who are more skillful and careful should set and fill in about the seedlings and tamp the roots, while the other two men or boys attend them with seedlings.

Stock can be rapidly set by placing ten to twenty seedlings at a time along in the trench at the proper distance apart; then quickly throw the earth in on one side, straighten up the plants, and firmly pack the earth about the roots with the foot. It should be borne in mind that very much depends upon the care and thoroughness with which this filling in and firming the earth is done. The fine earth should be well packed about all the roots, but not rammed. When the earth is carelessly and loosely thrown in about the roots and only lightly tamped, the trees are likely to die outright for lack of close contact with the soil.

Plants should be firmly set in the ground also to enable them to withstand as much as possible the loosening effect of winds, which, in exposed places, are likely to sway the stems and loosen the roots considerably. This may happen even to carefully set plants, especially in light loamy or mucky soils during heavy rains accompanied or followed by high winds. The nursery should, therefore, be looked over after such storms, and the loosened or partly washed-out seedlings should be straightened up, and the earth tightened about their roots.

CARE OF NURSERY STOCK.

CULTIVATION.

Following the transplanting of seedlings to nursery rows the care of this stock will be essentially the same as that described for plants in the seed bed. The nursery should be kept clear of weeds and the surface of the soil stirred frequently with hoe or cultivator, to prevent the evaporation of soil moisture. It is especially necessary that the nursery should be gone over after a rain with hoe or cultivator as soon as the surface soil is dried out sufficiently to work well. This will at once prevent the deeper moisture from drying out about the roots of the trees.

WATERING.

In case no rain falls within two weeks after the nursery plants have been set, the earth at the depth of the tree roots should be examined, and if found to be drying out or likely to do so in a short time, water should be applied to the rows. The method of watering described for seed beds will apply equally well to nursery rows. The earth should be thoroughly saturated at each watering down to the full depth of the roots. The maintenance of a moderately even supply of moisture in the soil should never be overlooked, for the success of the trees depends almost entirely upon proper moisture.

WINTERING.

Before leaving nursery stock for the first winter the rows should be hilled up on both sides. This can be done quickly by throwing one or two furrows against each side of the trees with a small corn plow and finishing with a hoe. In regions where the winters are only moderately cold this hilling up will give quite sufficient protection, while in mild regions of the Middle and Southern States no hilling will be necessary. But where the winters are severe a heavy mulching of green stable manure, leaves, or straw should be added to the hilling between the rows, covering the stems for at least a foot above the earth. Conifers may be mulched well up to the top. When straw or leaves are used for mulching a few rails, poles, or boards should be laid along each side of the nursery rows to prevent winds from blowing the mulch off.

As soon as growth begins in the spring the mulch should be taken off and the banking of earth hoed away from the rows.

HOW LONG STOCK SHOULD REMAIN IN THE NURSERY.

The object of continuing the cultivation of seedlings in the nursery is to make them vigorous and to bring them to a convenient size to insure successful transplanting in the forest plantation. This being accomplished, further nursery training is unnecessary. Sizes convenient for transplanting are from 12 to 18 inches in height.

For most conifers which have grown two years in the seed bed, one year in the nursery row will suffice before final planting; one-year-old seed-bed plants can with advantage be continued in the nursery for two years. The majority of broadleaf seedlings will be fitted for permanent planting with one year in the seed bed and one year in the nursery; further training of rapid-growing, broadleaf species in the nursery is likely to produce plants too large for convenient handling, while the essential vigor of these trees is not materially improved.

USE OF WILD SEEDLINGS.

Use wild seedlings whenever available; they are cheaper to collect or buy than plants raised from seeds. Strengthen wild seedlings by cultivating them in the nursery for one or two years.

The tree planter will usually find it profitable to use wild seedlings whenever possible. It will be considerably cheaper to buy or collect such seedlings than to raise them from the seed, and the additional cost or care in the nursery to fit wild stock for use will be comparatively small.

In general, wild seedlings are not as strong for planting as those of the same age grown in the nursery. This is chiefly for the reason that the wild stock has been established under conditions very different from those in the open, to which it is suddenly transplanted. Not infrequently some kinds of wild seedlings fail completely when transplanted directly from the woods to the open ground, or make very slow progress for a year or two until accustomed to the new situation. But the complete failure of wild seedlings to grow when transplanted from the woods applies mainly to carelessly pulled or otherwise badly handled seedlings. Success with wild seedlings of any age depends largely on the care with which they are taken up and planted. Generally speaking, forest seedlings from one to two or even three years old can be transplanted to the nursery with little loss, provided they are properly taken up, protected in transit to the nursery, and carefully set. Carefully lifted with a spade or otherwise correctly handled 80 per cent of wild conifer seedlings have been made to live. Broadleaf seedlings generally give a higher percentage.

Transplanted wild conifer seedlings need to be shaded during the first season.

SUPPLY OF WILD SEEDLINGS.

Wild seedlings are most abundant in wooded regions, near scattered seed trees where the conditions are favorable for seedlings to spring up. Few seedlings will be found under trees in pastures and dry fields. Wherever trees shed their seed in shaded moist soils there is the greatest likelihood of finding a supply of seedlings. The seedlings of the Pines, Spruces, Firs, Cedars, Junipers, Beech, Cherries, Catalpas, Tulip-tree, Maples, Ashes, Boxelder, Elms, Birches, and Aspens are most common where seed trees grow along water courses or in other moist situations.

Thousands of Willow, Cottonwood, and Boxelder seedlings can be found on the moist sandbars and edges of western streams.

TIME FOR COLLECTING WILD SEEDLINGS.

Wild seedlings may be taken up either in the spring or in the fall. If collected in the fall, broadleaf kinds should be taken up as soon as the leaves are shed, and conifers as soon as the winter buds are fully formed. According to the region, this will be from the middle of October to November; but all seedlings should be snugly packed in trenches ("heeled in") and covered with straw before the ground is frozen.

Spring collecting should be done as early as the frost leaves the ground, and before the buds begin to open.

The instructions given for taking up, handling, and transplanting seed-bed plants should be observed also in collecting wild seedlings.

HEELING IN.

Fall-collected wild seedlings are best temporarily placed in the ground for protection during the winter. In the spring they should be set out in nursery rows. Spring-collected trees may also need similar storing for a few days or weeks, till preparations can be made to plant them in the nursery. This temporary storing is called "heeling in," and consists in planting dense slanting rows of seedlings in a trench. The trees are covered with earth well up above the collar.

To insure the roots being perfectly moist when heeled in they should be first puddled in the manner described for transplanting seed-bed stock. To facilitate this work, a half barrel or large tub, instead of a bucket, may be filled with puddle and placed near the spot where the plants are to be heeled in, or a hole scooped out in the ground near by will serve perfectly well.

The puddle being prepared, and the plants near at hand, a trench is opened by sinking a spade deep into the ground at an angle of about 45 degrees, and throwing the earth out. A dense line of puddled trees is then laid against the slanting side of the trench and 6 inches of earth is thrown over the roots by spading along in front of the trench; this earth is firmly packed about the roots by foot pressure. Another line of plants is laid in the trench just opened by the spading in front, the stems being placed at about the same angle as in the first row. A 6-inch layer of earth is packed against the roots of the second row in the same manner as for the first, and the heeling in is thus continued till all the plants are taken care of. A foot or more of earth should be thrown up against the last row of plants to prevent any exposure of the roots by washing.

In transplanting heeled-in stock in the spring, the roots should be puddled.

LIST OF USEFUL TIMBER TREES TO PLANT.

The following list of trees includes such species as will be useful to the planter. It contains a short description of the habitat of each species. Notes on the appearance of the mature fruits and seeds are given for each species, and statements of the time to collect each kind of seed, the storage best suited to keeping it, and the time to sow it.

Geographical range of species, character of the seed, time to collect, and proper storage for seed of each species.

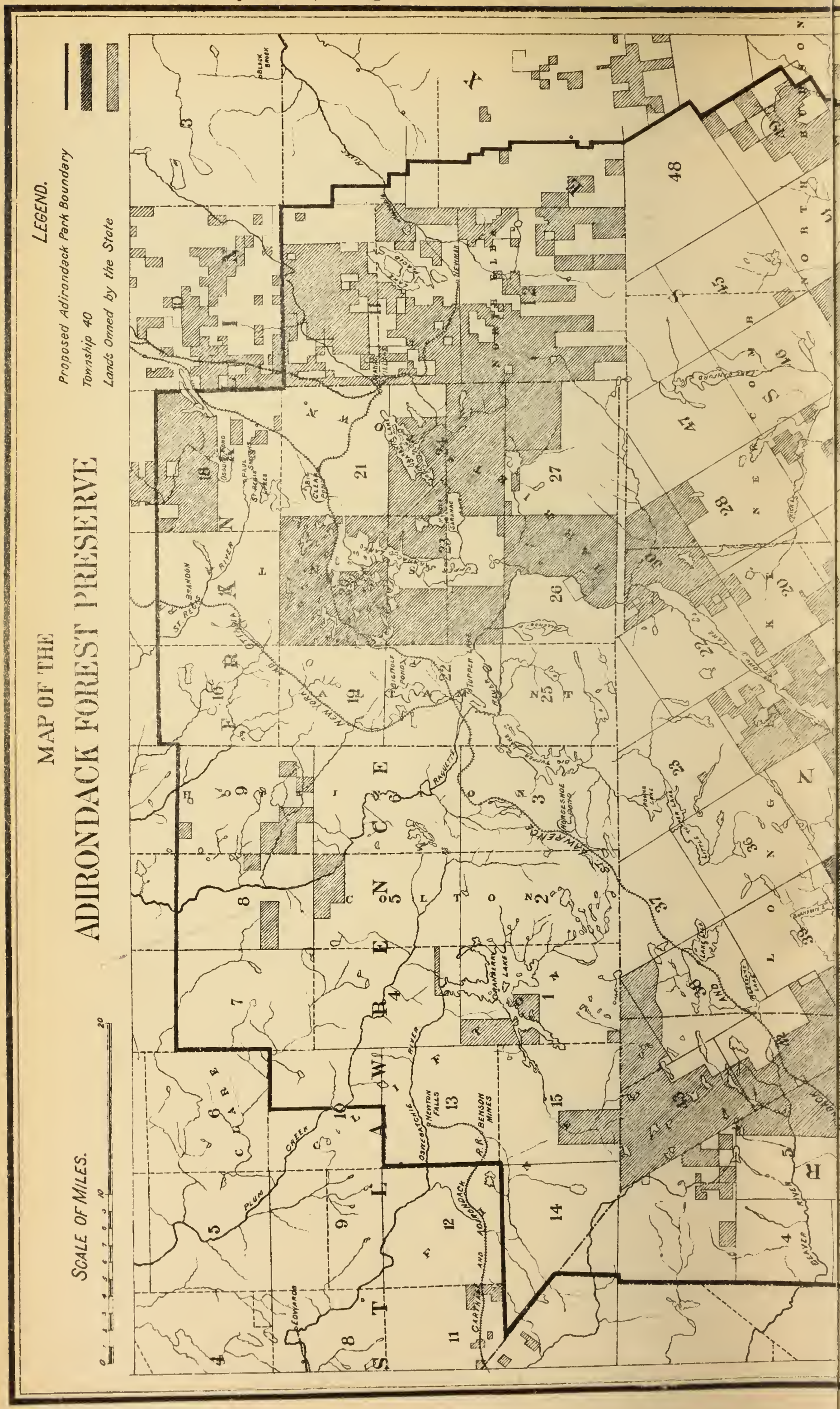
Name of species.	Where found.	Appearance and character of—		Time to—		Kind of storage.
		Fruit.	Seed.	Collect.	Sow.	
White Pine (*Pinus strobus*)	Eastern United States.	Long, smooth, light-colored, narrow, fragile, early-falling cone.	Small, mottled, with detachable papery wing.	Last weeks of August and September.	Spring	Dry and cold.
Bull Pine (*Pinus ponderosa*).	Rocky Mountains and westward.	Large, heavy, oval, prickly, strong, more or less persistent cone.	Medium large, mottled, with detachable papery wing.	September and October.	do	Do.
Shortleaf Pine (*Pinus echinata*).	South Central and Southern States.	Small, oval, light-colored, persistent, prickly cone.	Medium large, black-brown, with detachable papery wing.	do	do	Do.
Loblolly Pine (*Pinus taeda*)	Southern States	Medium, long, cylindrical, clay-brown, more or less persistent, prickly cone.	Medium large, black-yellow, mottled, with detachable papery wing.	do	do	Do.
Pitch Pine (*Pinus rigida*)	Mainly Northeastern States.	Medium, broad, conical, light russet-brown, very persistent, prickly cone.	Small, black, with detachable papery wing.	October and November.	do	Do.
Scrub Pine (*Pinus virginiana*).	Mainly Middle Atlantic States.	Small, oval, hard, very persistent, prickly cone.	do	do	do	Do.
Lodgepole Pine (*Pinus murrayana*),	Rocky Mountains and westward.	do	do	do	do	Do.
Banksian Pine (*Pinus divaricata*).	Northeastern United States.	Small, close, hard, very persistent, smooth cone.	Small, blackish, with detachable papery wing.	do	do	Do.
Longleaf Pine (*Pinus palustris*).	Southern States	Large, hard, tardily falling, prickly cone.	Large, clay-colored, with large papery wing.	do	do	Do.
Monterey Pine (*Pinus radiata*).	Southern California	Large, hard, thick-scaled, persistent smooth cone.	Small, black, with detachable with papery wing.	do	do	Do.
Tamarack (*Larix laricina*).	Northeastern States	Very small, fragile, persistent, smooth cone.	Minute, brownish, with papery wing.	September	do	Do.
Black and Red Spruce (*Piceamariana and Picea rubens*).	Mainly Northeastern States.	Small, firm (russet-brown), tardily falling, smooth cone.	Minute, brown, with detachable papery wing.	September and October.	do	Do.
White Spruce (*Picea canadensis*).	Northern States	Small, fragile (light-brown), tardily falling, smooth cone.	do	do	do	Do.
Blue Spruce (*Picea parryana*).	Rocky Mountain region.	Large, long, narrow, wrinkled-scaled (yellowish), smooth cone.	do	do	do	Do.
Engelmann Spruce (*Picea engelmanni*).	do	Small, short, wrinkled-scaled (red-brown), smooth cone.	do	do	do	Do.
Hemlock (*Tsuga canadensis*).	Northeastern States	Very small, fragile, tardily falling, smooth cone.	do	do	do	Do.
Red Fir (*Pseudotsuga taxifolia*).	Rocky Mountains and westward.	Small, fragile, bracted, early-falling, smooth cone.	Very small, mottled, with detachable papery wing.	do	do	Do.
Balsam Fir (*Abies balsamea*)	Northeastern States	Long, narrow, cylindrical, separable-scaled, smooth, upright cone.	Very small, angular, with detachable papery wing; resinous.	do	do	Do.
White Fir (*Abies concolor*)	Rocky Mountains and westward.	Medium-large, broad-cylindrical, separable-scaled, smooth, upright cone.	do	do	do	Do.
Bald Cypress (*Taxodium distichum*).	Southern States	Small, spherical, separable "ball".	Irregular, sharp-angular, woody; resinous.	do	do	Do.

Incense Cedar (*Libocedrus decurrens*).	Northwestern mountain and coast region.	Very small, narrow, fragile, few-scaled, deciduous, smooth cone.	Small, resinous, with tawny papery wing; fragrant.	do	do	Do.
Aborvitæ (*Thuja occidentalis*).	Northeastern States	do	Minute, with circular papery wing; with strongly balsamic odor.	do	do	Do.
Pacific Arborvitæ (*Thuja plicata*).	Northwestern coast region.	do	do	do	do	Do.
Lawson Cypress (*Chamæcyparis lawsoniana*).	do	Very small, spherical "ball"	Minute, with circular, papery wing.	do	do	Do.
Yellow Cedar (*Chamæcyparis nootkatensis*).	do	Very small, spherical, deciduous "ball" (foliage coarser).	do	September	Spring	Do.
Red Juniper (*Juniperus virginiana*).	Mainly northeastern States.	Very small, glaucous, resinous, tardily deciduous berry.	Minute, smooth, bony, pointed	September and November.	Spring or fall.	Bury in sand or earth.
Butternut (*Juglans cinerea*)	Eastern States	Large, deciduous, pointed, viscid-glandular, thin-husked nut.	Bony, jagged-rough, thick-shelled nut.	September and October.	do	Do.
Western Walnut (*Juglans rupestris*).	Southwestern States	Medium-large, spherical, thin-husked nut.	Bony, smooth, thin-shelled nut	do	do	Do.
Black Walnut (*Juglans nigra*).	Eastern States	Large, spherical, thick-husked nut.	Bony, rough, thick-shelled nut	do	do	Do.
Bitternut Hickory (*Hicoria minima*).	do	Medium-large nut, with thin and tardily separable husk.	Smooth, thin-shelled, bitter-fleshed nut.	do	do	Do.
Shagbark Hickory (*Hicoria ovata*).	do	Medium-large nut, with thick, deeply divided separable husk.	Thinnish, firm, 4-angled, compressed nut.	do	do	Do.
Shellbark Hickory (*Hicoria laciniosa*).	Central Eastern States.	Large nut, with very thick, deeply divided, separable husk.	Thick, strong, 4-angled, compressed nut.	do	do	Do.
Mockernut Hickory (*Hicoria alba*).	Eastern States	Large nut, with half-divided, tardily separable husk.	Thick, very strong, 4-angled nut	do	do	Do.
Pignut Hickory (*Hicoria glabra*).	do	Medium-large nut, with half-divided, tardily separable husk.	Thinnish, firm, smooth, compressed, oblique nut.	do	do	Do.
Black Willow (*Salix nigra*).	do	Long, narrow cluster of very small, soft, berry-like pods.	Minute, with cotton appendage	July	Sow pods at once.	
Aspen (*Populus tremuloides*)	do	do	do	do	do	
Large-tooth Aspen (*Populus grandidentata*).	Northeastern States.	do	do	do	do	
Cottonwood (*Populus deltoides*).	Eastern States	do	do	do	do	
River Birch (*Betula nigra*).	do	Small, cylindrical, separable-scaled cone.	Minute, circular-winged	May and June	do	
Yellow Birch (*Betula lutea*).	do	Small, oval, separable-scaled cone	do	September and October.	Spring or fall.	Dry and cold.
Sweet Birch (*Betula lenta*).	do	Small, oval, deciduous-scaled cone.	do	do	do	Do.
Beech (*Fagus atropunicea*).	do	Small, soft-prickly, tardily falling capsule.	Small, smooth, thin-shelled, triangular nut.	October and November.	do	Bury in sand.
Chestnut (*Castanea dentata*)	Mainly Atlantic States.	Very large, prickly, valvular, deciduous (capsule) bur.	Small, thin-shelled, flask-shaped nut.	do	do	Do.
White Oak (*Quercus alba*).	Eastern States	Small, deciduous, shallow-cupped acorn.	Small, smooth, oval nut	September and October.	do	Do.
Bur Oak (*Quercus macrocarpa*).	East of the Rocky Mountains.	Very large (or medium), mossy, deep-cupped acorn (nut tardily separable).	Large, smooth, oval nut	do	do	Do.

Geographical range of species, character of the seed, time to collect, and proper storage for seed of each species—Continued.

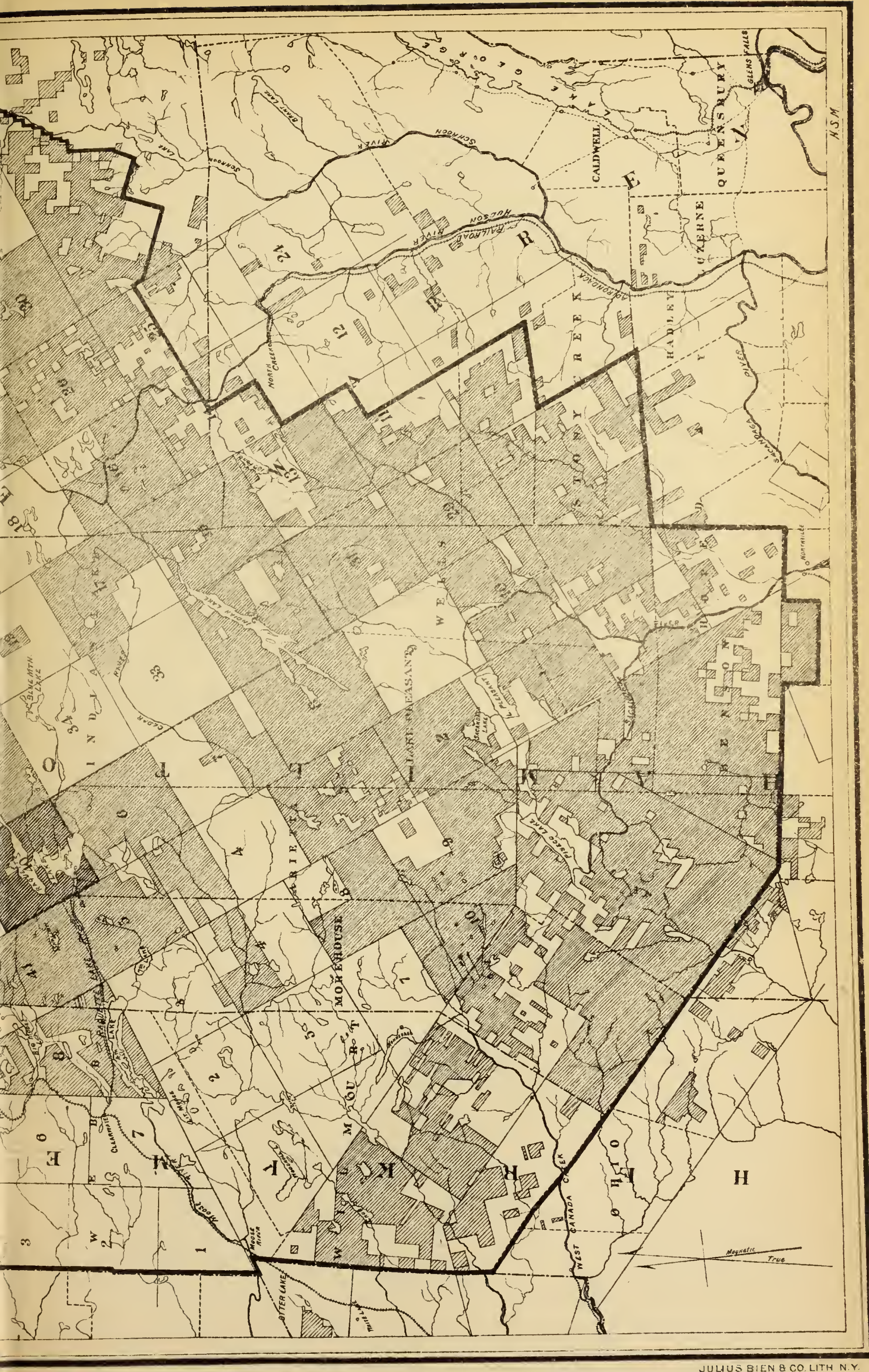
Name of species.	Where found.	Appearance and character of—		Time to—		Kind of storage.
		Fruit.	Seed.	Collect.	Sow.	
Overcup Oak (*Quercus lyrata*).	Southeastern States.	Medium large, very deep-cupped acorn; nut inseparable.	Large, smooth, oval nut	September and October.	Spring or fall.	Bury in sand.
Chestnut Oak (*Quercus prinus*).	Atlantic States	Large, shallow-cupped acorn	Large, smooth, long-oval nut	do	do	Do.
Chinquapin Oak (*Quercus acuminata*),	Eastern States	Small, shallow-cupped acorn	Small, smooth, oval nut	do	do	Do.
Swamp White Oak (*Quercus platanoides*).	do	Small, shallow-cupped acorn on long stems.	do	do	do	Do.
Cow Oak (*Quercus michauxii*).	Southeastern States	Large, deep-cupped acorn	Large, smooth, oval nut	do	do	Do.
Red Oak (*Quercus rubra*)	Eastern States	Large, very shallow-cupped acorn.	do	do	do	Do.
Yellow Oak (*Quercus velutina*).	do	Small, deep-cupped acorn	Small, smooth, striped nut	do	do	Do.
Spanish Oak (*Quercus digitata*).	Southeastern States	Very small, shallow-cupped acorn.	Very small nut	do	do	Do.
Black Jack (*Quercus marilandica*).	Eastern States	Small, deep-cupped acorn	do	do	do	Do.
Laurel Oak (*Quercus laurifolia*).	Southeastern States	Small, shallow-cupped acorn	do	do	do	Do.
Cedar Elm (*Ulmus crassifolia*).	Southwestern States	Small, thin, winged disk	Not separable from wing	September	Fall	
Slippery Elm (*Ulmus pubescens*).	Eastern States	do	do	May and June	Sow at once	
White Elm (*Ulmus americana*).	do	do	do	do	do	
Cork Elm (*Ulmus racemosa*).	Northeastern States	do	do	do	do	
Winged Elm (*Ulmus alata*).	Southeastern States	do	do	April and May	do	
Hackberry (*Celtis occidentalis*).	Eastern States	Small, dry, sweetish, thin-fleshed berry.	Not separable from pulp	October	Spring or fall.	Bury in sand.
Sugarberry (*Celtis mississippiensis*).	Southeastern States	do	do	September and October.	do	Do.
Red Mulberry (*Morus rubra*).	Northeastern States	Resembling a blackberry (longer).	Minute, smooth, hard	July and August.	Spring	Dry and cold.
White Mulberry (*Morus alba*).	Naturalized (from China).	do	do	do	do	Do.
Russian Mulberry (*Morus alba tartarica*).	do	do	do	do	do	Do.
Osage Orange (*Toxylon pomiferum*).	South Central States, but widely introduced.	Large, orange-like, seed embedded in milky pulp.	Resembles cucumber seed	September and October.	do	Dry and cold or mixed with sand.
Tulip-tree (*Liriodendron tulipifera*).	Eastern States	Small cone with overlapping, separable scales.	Curved, with lance-like wing	October	Spring or fall.	Bury in sand.

Sweet Gum (*Liquidambar styraciflua*).	....do	Small, hooked, long-stemmed ball ("gum ball") (size of hickory nut).	Very small, with detachable papery wing.	September and October.	....do	Do.
Sycamore (*Platanus occidentalis*).	....do	Small, rough, long-stemmed ball, formed of seed (size of hickory nut).	Very small, awl-like, bristly	October and November.	....do	Do.
Service-tree (*Amelanchier canadensis*).	....do	Very small cluster of berries (size of currants).	Minute, smooth		....do	Dry and cold.
Canada Plum (*Prunus nigra*).	Northeastern States	Small, oval, orange-red plum	Flat, bony	August	....do	Bury in sand.
Wild Plum (*Prunus americana*).	Central and Southeastern States.	Small, spherical, orange-red plum	....do	....do	....do	Do.
Black Cherry (*Prunus-serotina*).	Eastern States	Long cluster of very small thin, bitter-fleshed cherries.	Small, smooth, spherical, bony shell (¼ inch diameter).	....do	....do	Dry and cold best. Bury in sand.
Huisache (*Acacia farnesiana*).	Southwestern States	Thick, stout, cylindrical, red-brown, wavy pod (pea-like); hard to open.	Smooth, light-brown, bony (¼ inch diameter).	July and August	....do	Bury in sand.
Honey Locust (*Gleditsia triacanthos*).	Eastern States	Long, ribbon-like, twisted pod (hard pulp, sweet).	....do	October	....do	Do.
Kentucky Coffeetree (*Gymnocladus dioicus*).	Central and Northeastern States.	Very thick, broad, large, pod: hard to open (jelly-like pulp, poisonous).	Smooth, circular, bony (size of Chestnut).	October and November.	....do	Do.
Locust (*Robinia pseudacacia*).	Eastern States	Small, thin, easily opened pod	Smooth, bony (⅛ inch)	October	....do	Do.
Sugar Maple (*Acer saccharum*).	....do	In short clusters, medium, 2-winged (samaras).	Wings of equal size	....do	Spring or fall.	Do.
Silver Maple (*Acer saccharinum*).	....do	In short clusters, large, 2-winged (samaras).	One wing small and the other very large.	May and June	Sow at once	
Red Maple (*Acer rubrum*)	....do	In short clusters, small, 2-winged (samaras).	Wings of equal size	....do	....do	
Boxelder (*Acer negundo*)	....do	In long clusters, medium, 2-winged (samaras).	....do	October and November.	Spring or fall.	Bury in sand.
White Ash (*Fraxinus americana*).	....do	In dense clusters, 1-winged keys	Bluntly awl-shaped, long wing at end.	October	....do	Do.
Red Ash (*Fraxinus pennsylvanica*).	....do	....do	Sharply awl-shaped, long wing at end.	....do	....do	Do.
Green Ash (*Fraxinus lanceolata*).	....do	....do	....do	....do	....do	Do.
Common Catalpa (*Catalpa catalpa*).	Mainly Southeastern States, but widely cultivated.	Long, brittle, cylindrical pod, (mostly 8–14 inches long).	Light, thin, narrow, 2-lobed, with two fringed wings.	October and November.	....do	Dry and cold.
Hardy Catalpa (*Catalpa speciosa*).	Mainly South Central States.	Long, brittle, cylindrical pod, (mostly 12–20 inches long).	Light, thin, broad, 2-lobed, with two fringed wings.	....do	....do	Do.



MAP OF THE

ADIRONDACK FOREST PRESERVE



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BULLETIN NO. 30.
U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF FORESTRY.
GIFFORD PINCHOT, Forester.

A
FOREST WORKING PLAN
FOR
TOWNSHIP 40,
TOTTEN AND CROSSFIELD PURCHASE, HAMILTON COUNTY,
NEW YORK STATE FOREST PRESERVE.

BY

RALPH S. HOSMER, Field Assistant, and EUGENE S. BRUCE, Lumberman,
Division of Forestry, U. S. Department of Agriculture,

PRECEDED BY

A DISCUSSION OF CONSERVATIVE LUMBERING AND THE WATER-SUPPLY,

BY

FREDERICK H. NEWELL, Hydrographer,
U. S. Geological Survey.

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bed of humus or the forest floor, which does more than any other part of the forest to retain and protect the water-supply, will not suffer at all in its water-conserving capacity, and the increased danger from fire which usually follows lumbering will not be incurred. Consequently the water-supply would not be unfavorably affected by its adoption.

In order to complete the protection that the forests of Township 40 afford to the upper watersheds of several important streams, it is essential that something be done toward regulating these streams. A beginning has been made in the construction of a small dam for maintaining the level of Raquette Lake. It is recommended in the working plan that this dam be replaced by a permanent structure, better adapted both for driving logs and for insuring a permanent water level in Raquette Lake. This level should be marked upon the proposed dam and should govern the official in charge in keeping the level of the lake at the right point. In the working plan the building of a new dam is fully discussed, and since the present level has come to be generally recognized as being the level best adapted to meet the varied interests at Raquette Lake, it has been accepted as practically established.

In the construction of the dam devices can be arranged at small cost by which accurate record and computation can be made of the daily flow, thus furnishing facts of great value in discussing the effect of forests on water conservation, and enabling those in charge to regulate the discharge of water from the lake in such way as to insure the best conditions for driving logs and for navigation. Systematic records made on different streams under varying conditions, and extending over a sufficient period to give trustworthy results, afford the most valuable source of information regarding stream flow. Records of this sort are especially needed at those points where the streams, though still in or near the forest, reach a large enough size to become important as feeders of the great rivers or as sources of power. At such points the influence of the forest on the watershed can best be studied, because fewer factors enter into the problem than lower down the stream. Comparison of watersheds generally similar in topography, but with different forest cover, as for example a forested area with one which has been heavily cut over, will yield results from which much may be learned.

There is great need of such records in order to discuss intelligently the effects of forest upon river flow, for while it is generally recognized that forest preservation has a beneficial influence, the extent of this influence has never been accurately determined, and there is wide diversity of opinion as to how far-reaching it is. On hardly any phase of forestry has there been more discussion than on this, and on hardly any is there so slight a basis of known fact on which to rest the argument. It is very necessary that a definite understanding be reached on this point, for on the available supply of water depend many of the greatest industries of the country. Particularly is this true of New York State, where the canals and waterways play so large a part in the domestic commerce. Furthermore, it is eminently desirable that a definite understanding be reached of the fluctuation of streams which furnish power to mills or for navigation. The prospective manufacturer must know what to expect of a given stream before he will invest his capital in an undertaking dependent on it.

It is important to reduce these conclusions to a definite basis, expressed, if possible, in such form as to make it possible to estimate the actual value to the people or to the State of the better regulation of the stream. For instance, if it will cost a thousand dollars to preserve forest conditions upon a given tract, it is important to know whether the benefits thus derived will aggregate $2,000 or only $500. We can estimate the value of the timber, but the principal unknown factor is the valuation to be placed upon the improved condition of the streams. This valuation, as already said, can be reached only when a series of measurements have been made of the outflow from forest tracts and from similar areas which have been denuded.

Raquette Lake is the only body of water of considerable size in Township 40, but it is equally important to collect similar data at other lakes and ponds within the Adirondacks. One of the first steps in preparing to formulate a scheme of forest protection for the benefit of the water-supply should be a study of the uses of the water, and of how the flow should be regulated to make the benefit the largest possible. This work should be undertaken wherever practicable on the streams of the Adirondacks, and especially at such locations as the proposed dam at the outlet of Raquette Lake. These examinations, together with a thorough knowledge of the fluctuation of the lower streams and of the utilization of the water by mills or municipalities, will lead to a definite understanding of a highly important subject.

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A FOREST WORKING PLAN FOR TOWNSHIP 40, TOTTEN AND CROSSFIELD PURCHASE, HAMILTON COUNTY, N. Y.

SUMMARY.

The conclusions reached by the Division of Forestry of the United States Department of Agriculture after a thorough study of the forest problems of Township 40 are briefly summarized below. A detailed discussion of these conclusions follows in the working plan.

First. Under the systematic and conservative system of management advised in this working plan there would be no interference whatever with the value of the forest as a conserver of the water-supply. To this end ample reservations are recommended, which would thoroughly protect the watersheds and preserve the lake shores from damage. This statement as to watersheds and water-supply has been confirmed by Mr. F. H. Newell, Hydrographer of the United States Geological Survey, who, after personal examination of Township 40, has approved the recommendations made in this working plan. Particular attention would be given to the protection of the mountain summits and the natural beauties of Raquette Lake. Only the mature softwood timber would be cut, and that under close restrictions and constant supervision.

Second. Township 40 is a well-timbered township, on which there is a sufficiently heavy stand of mature Spruce to insure profitable lumbering under economical and conservative methods. There is also mature Pine and Balsam which should be cut.

Third. The topography of this township makes lumbering comparatively easy, since the greater part is tributary to Raquette Lake, which occupies the center of the township. The Raquette Lake Railway is at present the only means of getting the timber from Township 40 to the market. With the improvement of the river between Raquette and Forked lakes, which is strongly advised in this working plan, a second outlet would be secured for the timber on the greater part of Township 40, and also for all other timber tributary to Raquette Lake. The improvement of this river, so that logs might be driven from Raquette Lake, would make a material improvement in the bids submitted for the stumpage.

Fourth. Township 40 is covered by virgin forest. In a forest of this character the annual decay of the overmature trees offsets the annual growth. Each year many large trees die or are blown down and decay. These mature trees, if harvested, would yield a considerable revenue, and at the same time, the producing power of the forest being unimpaired, the conditions of growth would be improved. Under conservative lumbering successive crops may be cut from this forest at recurring intervals for an indefinite period.

Fifth. Under practical forestry this tract would yield a sustained revenue. By the adoption of a conservative and carefully devised system of lumbering, such as that advised in the working plan for

Township 40, the State would receive a sustained and increasing income from the Forest Preserve. This would bring about the right use of the forest resources of the State lands without in any way interfering with the objects for which the Forest Preserve was created, and without injury to its natural beauties.

From this statement it will be seen that the lumbering of the softwood timber under forest management is safe, practicable, and can be readily made profitable financially; that lumbering under the rules incorporated in the present working plan would tend to improve the condition of the forest, and increase its productive capacity; that such lumbering would remove overmature trees which by deterioration and decay offset the production of the forest in sound timber, and that all this may be accomplished wholly without interference with the water-supply or with any of the other objects of the Preserve.

The Division of Forestry therefore recommends that the necessary steps be taken to secure the lumbering of Township 40 by conservative methods.

Thorough supervision of the lumbering advised in this working plan for Township 40, by trained men, is essential to the improvement of the forest, to a sustained supply of timber, and to the preservation of the water-supply. Upon the efficiency of the supervision will depend the success of the results obtained by adopting this working plan.

INTRODUCTION.

The New York State Forest Preserve comprises an area of 1,370,928 acres, of which 1,290,987 are in the Adirondack Preserve and 79,941 in the Catskill Preserve. This large public reservation was set apart to "be forever reserved, maintained and cared for as ground open for the free use of all the people for their health and pleasure and as forest lands, necessary to the preservation of the head waters of the chief rivers of the State, and a future timber supply; and shall remain part of the forest preserve." For these purposes it was essential to preserve the forests; and so important was it considered to put them beyond the possibility of destruction that in 1894 an amendment to the constitution was adopted prohibiting absolutely the cutting or sale of any timber on land owned by the State within the Forest Preserve. Additions to the Preserve are made by the Forest Preserve Board. Its administration is in the hands of the Forest, Fish and Game Commission, whose engineer, the Superintendent of State Forests, has "charge of all work connected with the care and custody of the forest preserve."

Besides protecting the water-supply and furnishing a recreation ground, the Preserve is destined to become of great value to the people of the State as a permanent source of timber-supply. Far from being inconsistent with the other interests for which it is maintained, its conservative utilization for this purpose will rather advance them. Experience has shown that the great enemy of the forest is fire, not lumbering. Forestry, the aim of which is to harvest successive crops, must protect and improve the forest. This it does by removing the mature trees in such a way that reproduction of the forest is secured and its continued productive existence is maintained. The trees which have passed their prime give place to a vigorous young growth, which, properly handled and protected, makes certain the future usefulness of the forest as a source of timber-supply. At the same time its beauty is unimpaired and its general condition improved.

Realizing the importance of a systematic and conservative plan for the management of the State forests along these lines, the Forest, Fish and Game Commission requested the cooperation of the United States Department of Agriculture in the study of the forest conditions of the Adirondack Preserve. The request was made in the face of the existing amendment to the constitution, adopted in 1894, which governs the Forest Preserve. This amendment reads as follows:

> The lands of the State, now owned or hereafter acquired, constituting the forest Preserve as now fixed by law, shall be forever kept as wild forest lands. They shall not be leased, sold or exchanged, or be taken by any corporation, public or private, nor shall the timber thereon be sold, removed or destroyed.

It is understood that the main object of the Commission in making the request for the cooperation of the Department of Agriculture in the study of the Adirondack Preserve was to set before the people of the State the reasons why the above clause in the constitution should be so modified that the forest might be properly utilized and administered. These reasons are set forth in this working plan. The request was made under the terms of an offer by which the Department of Agriculture, through the Division of Forestry, offers to cooperate with owners in the preparation of working plans for forest lands which present favorable conditions for systematic and conservative management.[1]

APPROPRIATION.

Under the timber-land agreement of the Division of Forestry, the salaries of the agents of the Division are paid by the Department of Agriculture, while the owner of the land pays their expenses for traveling and subsistence. To meet the initial expenses of the work requested by the Forest, Fish and Game Commission, the legislature of the State of New York during the session of 1900 appropriated $2,000. This was to be expended by the Superintendent of State Forests "for the payment of the expenses of experts furnished by the United States Bureau of Forestry for estimating standing timber and other information regarding the lands and trees in the forest preserve."

It was decided by the Superintendent of State Forests and the Forester of the United States Department of Agriculture that the first working plan should be made for the tract known as Township 40, in Hamilton County, which contains Raquette Lake. Here, during the summer of 1900, the necessary field work was carried out by a party from the Division of Forestry, assisted by the three foresters of the Forest, Fish and Game Commission.

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[1] Practical Assistance to Farmers, Lumbermen, and Others in Handling Forest Lands. Circular No. 21, Division of Forestry, United States Department of Agriculture, October, 1898.

OBJECT OF THE WORKING PLAN.

The main purpose of this working plan is to outline a method of management under which the merchantable timber may be cut in such a manner that successive crops may be obtained and the condition of the forest constantly improved.

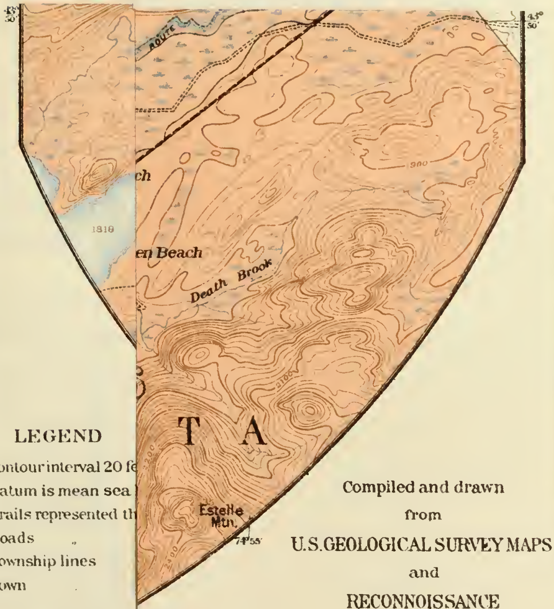
In order to decide how to make the first cutting so as to insure successive crops within a reasonable time and at a profit to the owner (in this case the State of New York), it is necessary to know the present stand of timber and of immature trees, and what the rate of growth of the latter will be after the mature trees have been removed. The making of the necessary measurements, with a thorough study of the habits and reproduction of the principal species, constitutes the chief field work incident to the preparation of the working plan, while the plan itself sets forth the advised method and manner of treatment.

In this study of a portion of the Adirondack Preserve, the intention has been to devise a system whereby the forest may be utilized without sacrificing the objects for which the Preserve is held.

In the preparation of a forest working plan the first step is necessarily a thorough study of the quality and amount of the merchantable timber and of transportation and market. A definite understanding of these things is necessary alike for the lumberman and for the forester. It is the basis on which each of them must form his judgment as to the amount of timber on the land, the diameter limit to which he may cut, the area to be logged over, and the probable profits to be obtained. Such a study of the whole situation is essential if the work is to be financially profitable.

There are, however, two points of view from which this situation may be regarded. The lumberman is primarily interested in the present crop and seeks the most profitable method of harvesting all the merchantable timber, with little or no thought for the future. The forester, on the other hand, is concerned not only with the profitable lumbering of the mature timber, but with lumbering it in such a way that the forest may be lumbered again and again. In these two points of view lies the radical difference between the lumberman and the forester.

The forest working plan is dependent on a knowledge of the future growth of the commercially important trees, for on the amounts which can be cut in the future, and on the time which must elapse before such cuts can be made depends in large measure what the present cut shall be, how much shall be lumbered, and how many years



LEGEND

Contour interval 20 fe
Datum is mean sea
Trails represented th
Roads „
Township lines
Town

OWNERSHIP R
State Lands
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Private Lands

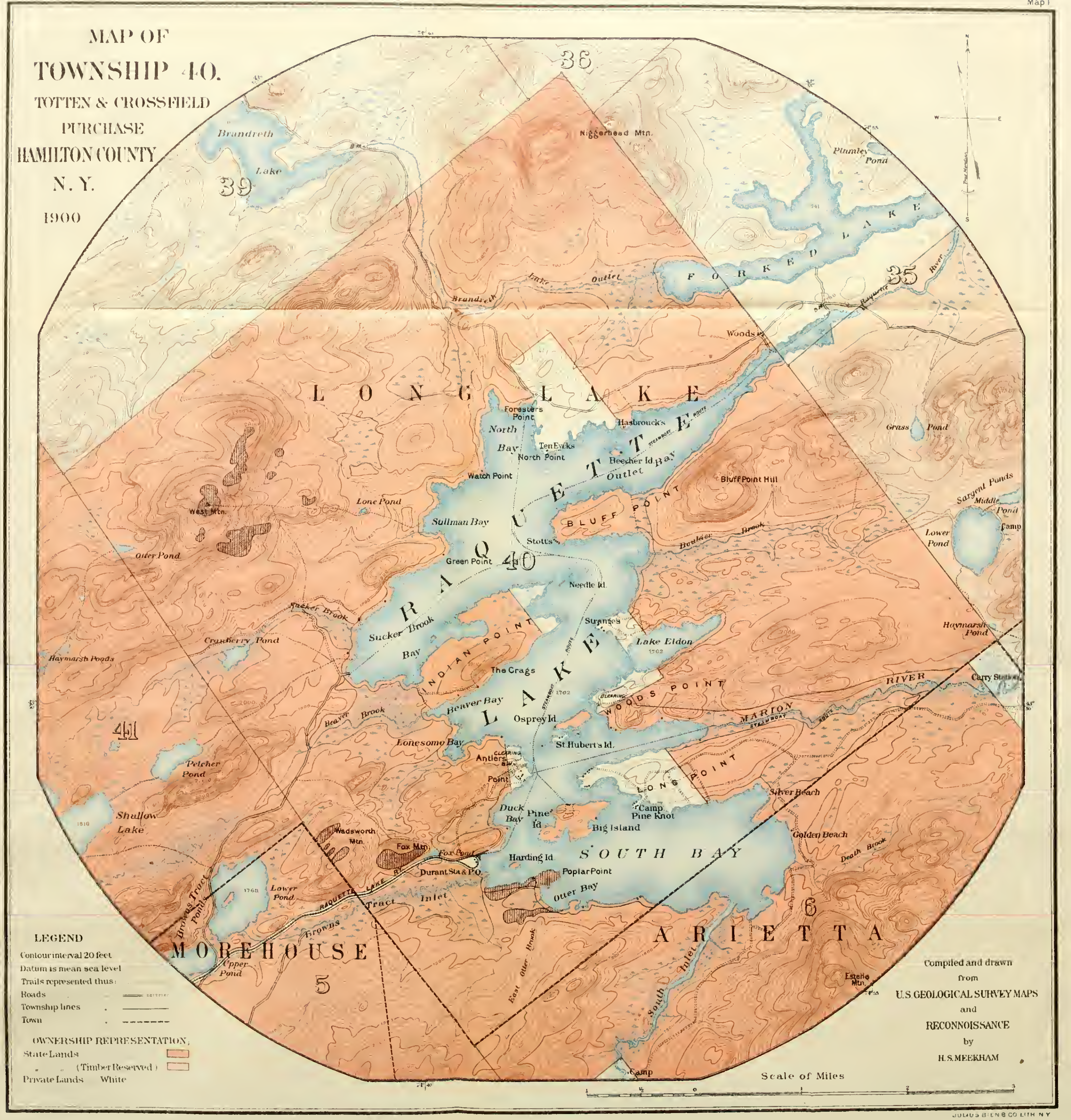
Miles
2 3

Compiled and drawn
from
U.S. GEOLOGICAL SURVEY MAPS
and
RECONNOISSANCE
by
H. S. MEEKHAM

JULIUS BIEN & CO. LITH. N.Y.

MAP OF TOWNSHIP 40.

TOTTEN & CROSSFIELD PURCHASE
HAMILTON COUNTY
N. Y.
1900



LEGEND

Contour interval 20 feet
Datum is mean sea level
Trails represented thus :
Roads
Township lines
Town

OWNERSHIP REPRESENTATION.

State Lands
" " (Timber Reserved)
Private Lands White

Compiled and drawn
from
U.S. GEOLOGICAL SURVEY MAPS
and
RECONNOISSANCE
by
H. S. MEEKHAM

Scale of Miles

1 ½ 0 1 2 3

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must intervene between cuts. It is highly important that the figures on which these estimates are based should be accurate. To insure this, a very careful method of estimating standing timber has been adopted by the Division of Forestry, by which not only is the stand of merchantable timber found, but also the stand of the smaller trees from which the future harvests are to come. The method is explained in detail later (p. 21). The estimates of future yield are made by counting on felled trees the annual rings on the stump and at the top of each log, by careful diameter and height measurements, and by other means which aid in reading the life history of the trees. From a large number of these measurements tables are constructed, showing the number of years required by the trees to grow 1 inch in diameter on the stump. The present stand of small trees on a given area and their rate of growth being known, the future stand and yield may be predicted.

GENERAL DESCRIPTION OF TOWNSHIP 40.

Township 40 lies in what is known as the Totten and Crossfield Purchase. It is situated in the west central section of the Adirondack Park, in the northwest portion of Hamilton County, and forms part of the town of Long Lake. The situation of Township 40 in the Adirondack Park is shown on the frontispiece map. It forms, with adjoining State lands, one of the largest and most compact blocks of State land within the limits of the Park. Referring to Map I it will be seen that Township 40 is bounded wholly on two sides and partly on a third by State land, all of which is covered by virgin forest. On the east side, on the south half of Township 35, the State does not own the softwood timber, which was reserved when the tract was acquired.

The lines of Township 40, in common with those of other tracts in the Totten and Crossfield Purchase, run N. 63° E. and N. 27° W. These lines are known among the Adirondack surveyors as "10 and 2 o'clock lines," signifying that shadows would be thrown along the lines at the hours named. The lines running N. 63° E., which will be referred to as the north and south lines, are, approximately, 6 miles in length. The east and west lines are about 6½ miles. The total area is 25,660 acres.

The township is reached by the Raquette Lake Railway, the terminus of which is Durant, on the shores of Raquette Lake. This railroad makes track connection with the Adirondack branch of the New York Central and Hudson River Railroad at Clearwater, 19 miles from Durant, bringing Raquette Lake within 77 miles, by rail, of Utica on the main line.

A steamboat line on Raquette Lake connects Durant with Blue Mountain Lake, while another line to Long Lake via Forked Lake is projected. At Durant are ample wharves, where steamboats can conveniently load, and a car float conveys loaded freight cars to Blue Mountain Lake or to a wharf at the lower end of Raquette Lake. (Pl. I, figs. 1 and 2.)

TOPOGRAPHY.

There are three watersheds on Township 40, the largest and most important containing Raquette Lake, which lies in the middle of the township. Raquette Lake is part of the Raquette River drainage system, and receives the waters of Blue Mountain Lake, one of the principal sources of the Raquette River, through Eagle Lake, Utowana Lake, and Marion River. The other important streams which flow into Raquette Lake are South and Browns Tract inlets and Sucker, Boulder, and Beaver brooks.

The waters of Raquette Lake flow into Forked Lake, thence through Long Lake into the Raquette River, and at last into the St. Lawrence. Its altitude is 1,762 feet above sea level.

Of the two other watersheds on Township 40 one is formed by the low hills along the lake shore and the mountains north and west of the lake, which include Nigger Head and Pilgrim. This watershed is tributary to Forked Lake and Brandreth Lake Outlet. The latter flows across the northern part of the township from west to east and empties into an arm of Forked Lake extending into Township 40. (Pl. II, fig. 1.) This stream drains Brandreth Lake on Township 39, and is an important feature in the topography of Township 40.

The third watershed lies on the southwestern slopes of West Mountain, and drains into the Big Moose Lake system.

West Mountain is the highest point on the township; its altitude is 2,919 feet above the sea. (Pl. II, fig. 2.) Nigger Head and Pilgrim mountains are each a trifle over 2,800 feet. While the elevation of these mountains is not great, their steep sides and rugged summits give the township a distinctly mountainous character, which is the more noticeable from the absence of other peaks in the immediate vicinity. Between the lake and the higher mountains to the north and west the land is broken by hills. On the south side the mountains rise more abruptly, although they are not as high as those on the north and west sides. Along several of the inlets there is low, swampy land and some open marsh, but in general the ground is elevated.

The prevailing rock is granite, often exposed on the mountains and along the lake front. Where mineral soil appears on the surface it is a sandy gravel of glacial origin; but for the most part the ground is covered by a deep layer of vegetable matter. This is replaced by muck in the swamps. There are several sandy beaches along the lake shore, but the banks are generally rocky and covered with trees to the water's edge.

Topographically, the dominant feature is Raquette Lake. Occupying the center of the township and with its many miles of shore line,

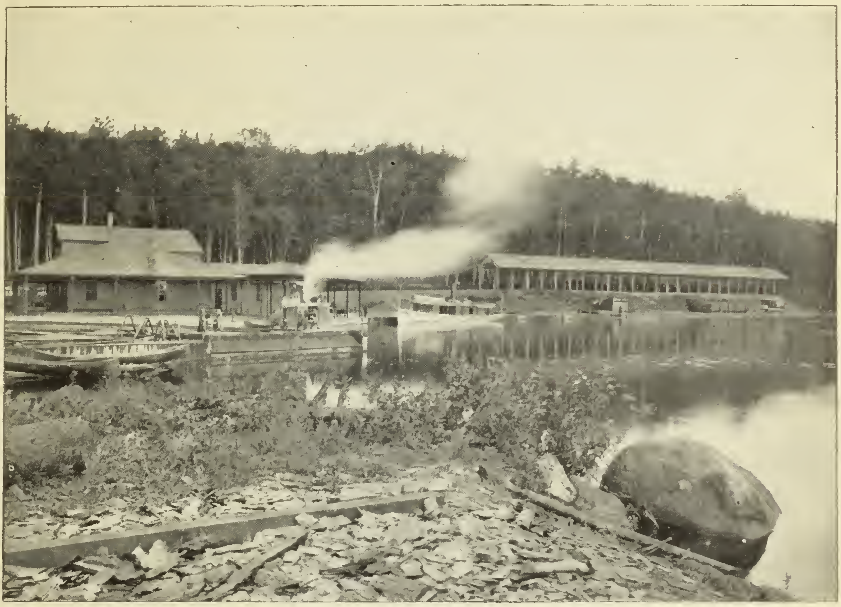


FIG. 1.—RAILROAD STATION AND STEAMBOAT WHARVES, DURANT.

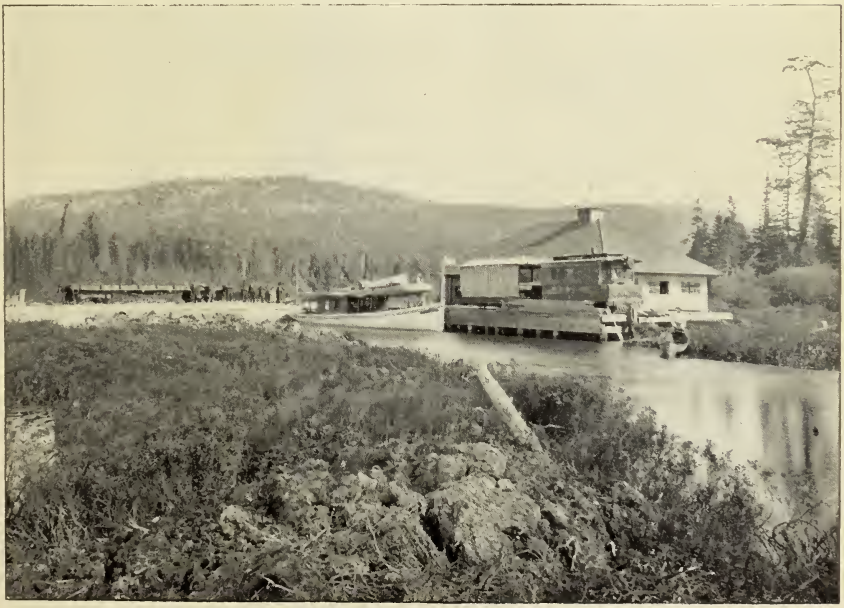


FIG. 2.—STATION AND WHARF, MARION RIVER CARRY, SHOWING CAR FLOAT WITH CAR.

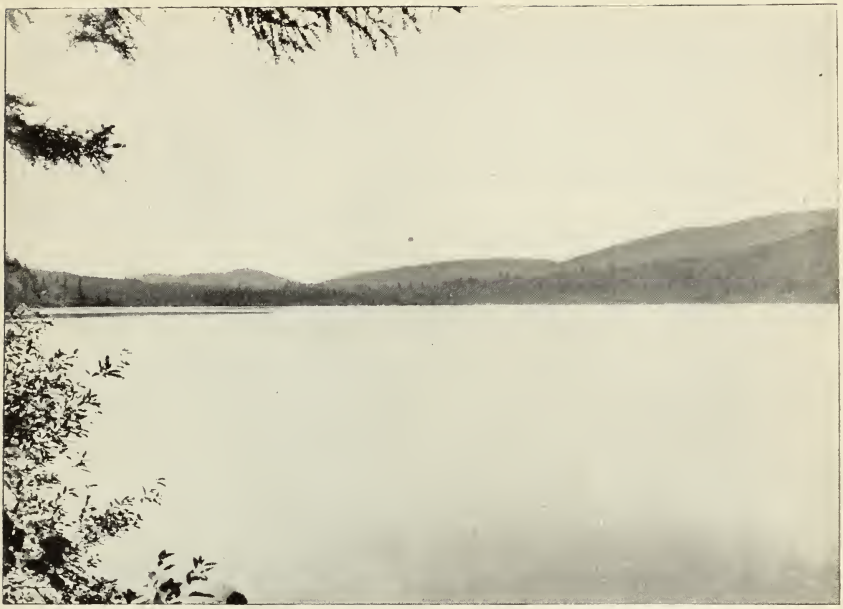


FIG. 1.—SOUTH END OF FORKED LAKE, FROM TOWNSHIP 40 LINE.

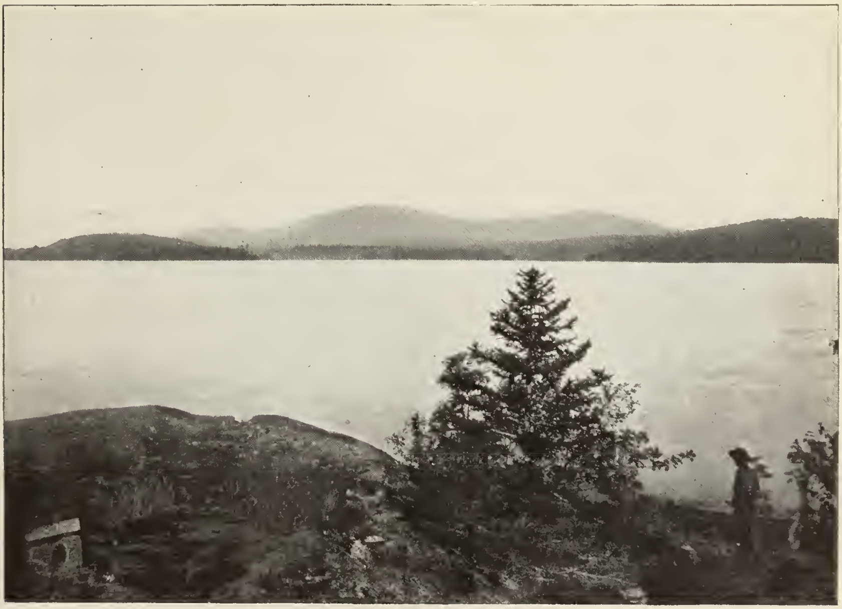
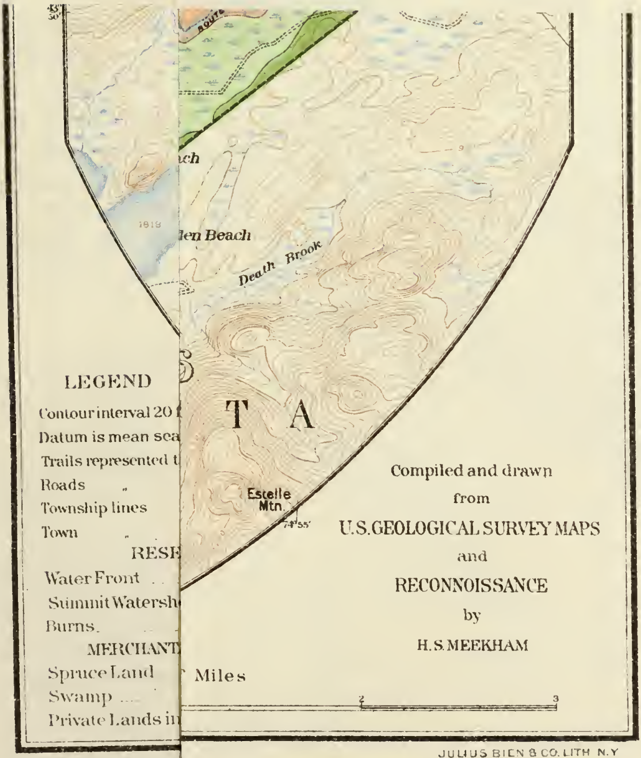


FIG. 2.—WEST MOUNTAIN, FROM BLUFF POINT, LOOKING INTO STILLMAN BAY.



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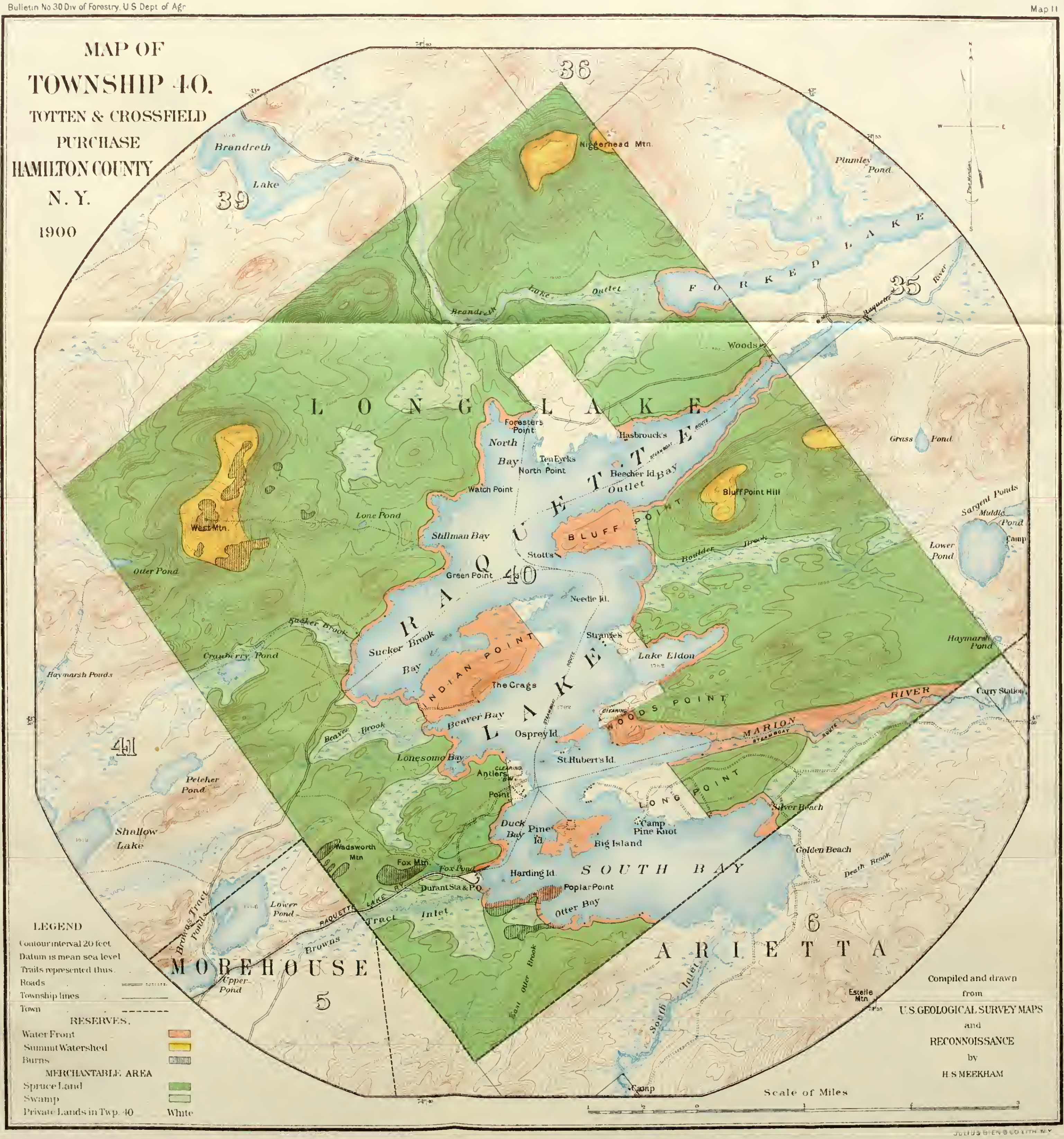

MAP OF
TOWNSHIP 40.
TOTTEN & CROSSFIELD
PURCHASE
HAMILTON COUNTY
N. Y.
1900

JULIUS BIEN & CO. LITH. N.Y.

broken by numerous points and large bays and by several picturesque islands, it gives character to the tract, and makes Township 40 one of the most interesting of the State's holdings.

THE FOREST.

The forest on Township 40, in common with that of the larger part of the Adirondack plateau, is a mixed forest of broadleaf (hardwood) and coniferous (softwood) trees, the latter predominating. The principal species are, in the order in which they occur: Spruce,[1] Yellow Birch, Balsam, Hemlock, Beech, Hard Maple, and White Pine. With these are associated Arborvitæ, commonly known as Cedar, Black Spruce, Tamarack, Red or Norway Pine, Soft Maple, and White Birch, with scattered White Ash and Black Cherry. Aspen, commonly known as Poplar, and Bird Cherry are found on the burned-over land. The underbrush is mainly Witch Hobble, Striped Maple or Moosewood, and Mountain or Spotted Maple.

Spruce so largely predominates on Township 40 that it makes this a characteristic Spruce township. This species forms 46 per cent of the trees in mixture.

FOREST TYPES.

In order to classify the forest and to make a more correct estimate of the standing timber, it is usual to recognize forest types. These depend largely on the situation, which to a considerable degree modifies the character of the forest, on the distribution of the various kinds of trees, and on their habits of growth.

On Township 40 the forest falls naturally into three principal types, which have been called Swamp, Spruce Land, and Upper Spruce Slope. The merchantable area of the forest (see Map II) contains only Swamp and Spruce Land. The area marked Summit Watershed Reserve on the maps is the Upper Spruce Slope land.

SWAMP.

The Swamp type includes the low-lying land along the main streams and inlets. It covers 1,977 acres, or 12 per cent of the merchantable area. In general, the elevation of the swamps is only slightly higher than that of the lake. Small areas of open marsh occur near the mouths of some of the streams, but most of the swamp land is covered by forest.

The characteristic species of the swamps are Spruce, Balsam, Cedar, Black Spruce, White Pine, and Tamarack. Within the swamps are found gravelly knolls, slightly elevated flats, and low ridges rising out of typical swamp land. On these occur White Pine and Hemlock in addition to Spruce, Balsam, and a few hardwoods.

On the lowest and most poorly drained land, immediately along the streams, grow the Tamarack and Cedar. The Tamarack in the Adirondacks suffered very heavily several years ago from a sawfly worm, which destroyed nearly all of the large trees. A living mature Tamarack is now rare on Township 40. In addition, the continued annual flooding of the low ground bordering the inlets of Raquette Lake, caused by the dam which maintains the lake at a proper level for steamboat traffic, has killed practically all the young Tamarack as well as the Cedar growing on this ground.

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[1] Wherever the word Spruce is used alone throughout this working plan it means the Red Spruce (*Picea rubens* Sargent).

It should be said here that the damage done by flooding is caused, not by the presence of very high water for a short time, but by holding the water above the normal level for considerable periods at a season of the year when tree growth is going on.

Cedar is also found scattered along the lake shores and bordering some of the brooks in the better drained Swamp and Spruce Land types. It reaches its best development in the latter situation, where the trees 10 inches and over at breastheight average 14 inches in diameter and 51 feet in height.

The Black Spruce found in the swamps is a small, spindling tree, of no commercial value. It is found on slightly higher ground than the Tamarack, and usually forms a pure stand. The Balsam is common in the dryer swamps, where trees 10 inches and over at breastheight average 11.1 inches in diameter and 63 feet high.

The White Pine in the forest of the Swamp type is limited to the gravelly knolls and low ridges. The Red Spruce is found on the better drained portions of Swamp, in mixture with the Balsam and Cedar, and on the ridges and low hills. While not reaching its best development, it is here of fair size and is the most important species in this type of forest as in all parts of the township.

The following table was obtained by counting the trees and measuring their diameters on 90 sample acres in the Swamp type. It shows the average number of trees per acre, the average and maximum diameters of each species, and the percentage in mixture for all sound trees 10 inches and over in diameter breasthigh.

Table No. 1.—*Swamp.*

[Average of 90 acres.]

(Sound trees 10 inches and over in diameter breasthigh.)

Name of species.	Average number of trees per acre.	Percentage of each species.	Average diameter breast-high.	Maximum diameter breast-high.
			Inches.	*Inches.*
Spruce	14.58	39.90	13.5	32
Birch	2.72	7.44	16.5	29
Beech	.03	.08	13.7	15
Hard Maple	.31	.84	14.5	20
Hemlock	1.94	5.30	15.0	27
Balsam	9.32	25.55	11.1	18
Soft Maple	.29	.79	17.5	20
White Pine	1.23	3.36	25.1	60
Cedar	5.68	15.54	13.3	25
Other hardwoods	.44	1.20	13.6	21
Average of all species	36.54	100.00	13.6	25.7
Average of all species except Spruce	21.96	60.10	13.7	25

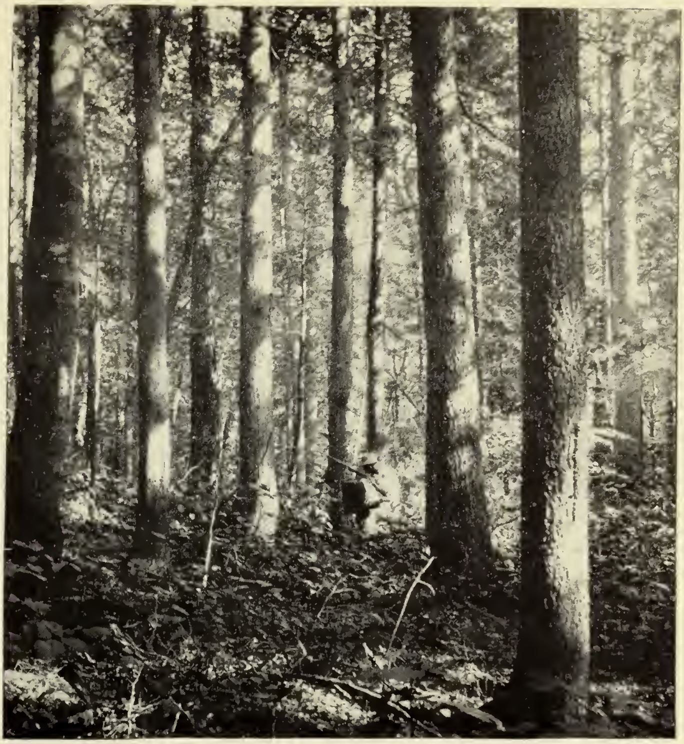

FIG. 1.—HEAVY SPRUCE STAND, TOWNSHIP 40.

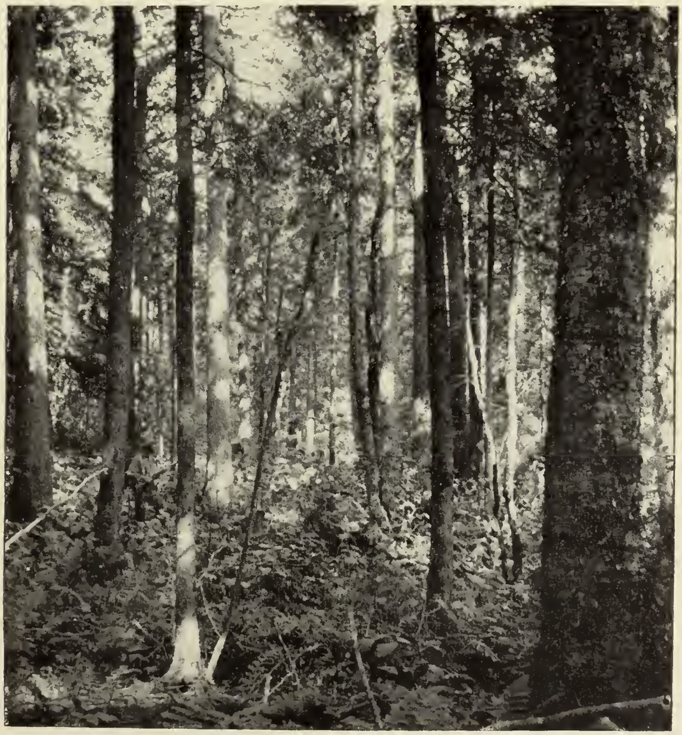

FIG. 2.—SPRUCE AND HARDWOODS IN MIXTURE, TOWNSHIP 40.

SPRUCE LAND.

This type includes the larger part of Township 40. It covers 14,919 acres, or 88 per cent of the merchantable forest area. A general characteristic is that it is well drained; it embraces the rising ground and the lower mountain slopes. Red Spruce is the predominant species, making 47 per cent of the trees in mixture. The principal species associated with the Spruce are Yellow Birch, Balsam, Beech, Hemlock, Hard Maple, and White Pine.

The Spruce reaches its best individual development in mixture with the hardwoods on the lower slopes of the mountains. (Pl. III, figs. 1 and 2.) For the trees 10 inches and over in diameter at breastheight the average diameter is 14.2 inches and the average height 72 feet. The maximum diameter is 35 inches.

On this type the hardwoods attain good diameter and height and reach their highest percentage in the mixture. Balsam is more common on the lower portions of the Spruce Land and on the flats, but is found in mixture throughout the forest. (Pl. IV, fig. 1.) The Hemlock grows best on the lower slopes of the principal mountains, where it is found in mixture with Spruce and hardwoods. It shows a marked tendency to grow in groups. The White Pine on this type is found mainly along the lake shores, where it seeks the sandy banks, growing pure or mixed with the Red (Norway) Pine.

On the Spruce Land 953 acres were measured. A summary of the results obtained is given in the following table:

TABLE NO. 2.—*Spruce Land.*

[Average of 953 acres.]

(Sound trees 10 inches and over in diameter breasthigh.)

Name of species.	Average number of trees per acre.	Percentage of each species.	Average diameter breast-high.	Maximum diameter breast-high.
			Inches.	*Inches.*
Spruce	24.23	46.17	14.2	35
Birch	8.98	17.11	19.0	42
Beech	4.70	8.95	15.3	30
Hard Maple	3.76	7.16	15.1	32
Hemlock	4.66	8.88	17.8	47
Balsam	4.82	9.18	11.4	24
Soft Maple	.45	.86	16.1	31
White Pine	.40	.76	26.5	49
Cedar	.32	.61	14.0	25
Other hardwoods	.17	.32	15.4	28
Average of all species	52.49	100.00	15.4	34.3
Average of all species except Spruce	28.26	53 83	16.4	34.2

UPPER SPRUCE SLOPE.

The third type, Upper Spruce Slope, has been made to include the summits and steep upper slopes of the chief mountains on the township. The lower limits of this type vary with locality, but seldom extend below an elevation of 2,400 feet. This includes the summits of West, Pilgrim, and Nigger Head mountains and Bluff Point Hill.

Spruce predominates, with a subordinate mixture of Birch, Hard Maple, Beech, and Balsam. The trees in this type suffer from poor soil and exposure, and do not reach the height of those in more favorable and sheltered situations. They often become stunted toward the mountain tops. The following table gives the average of the 37 acres of Upper Spruce Slope measured:

Table No. 3.—*Upper Spruce Slope.*

[Average of 37 acres.]

(Sound trees 10 inches and over in diameter breasthigh.)

Name of species.	Average number of trees per acre.	Percentage of each species.	Average diameter breast-high.	Maximum diameter breast-high.
			Inches.	*Inches.*
Spruce	29.68	62.21	13.9	34
Birch	8.62	18.07	19.7	34
Beech	3.38	7.08	15.0	26
Hard Maple	4.38	9.18	17.4	28
Hemlock	.62	1.30	17.7	30
Balsam	.76	1.59	12.0	17
Soft Maple	.19	.40	15.4	18
Other hardwoods	.08	.17	14.5	17
Average of all species	47.71	100.00	15.4	24.5
Average of all species except Spruce	18.03	37.79	17.8	24.5

FIRE.

The forest on Township 40 has been unusually free from damage by fire. The burned areas, indicated on the maps by shading, are small in extent and in importance. The only burn of recent date is one of about 5 acres, which occurred during the summer of 1899. Mention of this burn is made in the Report of the Superintendent of State Forests to the Fisheries, Game and Forest Commission for that year.[1]

All the other burns on this township are old, dating back from twenty to fifty years. These old burns have largely grown up to White Birch, Cherry, and Aspen, followed by Spruce and hardwoods, which now form a vigorous young stand on these areas. (Pl. IV, fig. 2.) All told, the burns on the township form only 1 per cent of the forested area.

RESERVED AREAS.

WATERSHED RESERVE.

One of the chief values of the Adirondack Preserve is in the preservation of the upper watersheds of important rivers. Nowhere is

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[1] Preliminary Report to the Fifth Annual Report of the Commissioners of Fisheries, Game and Forest. Albany, 1900.

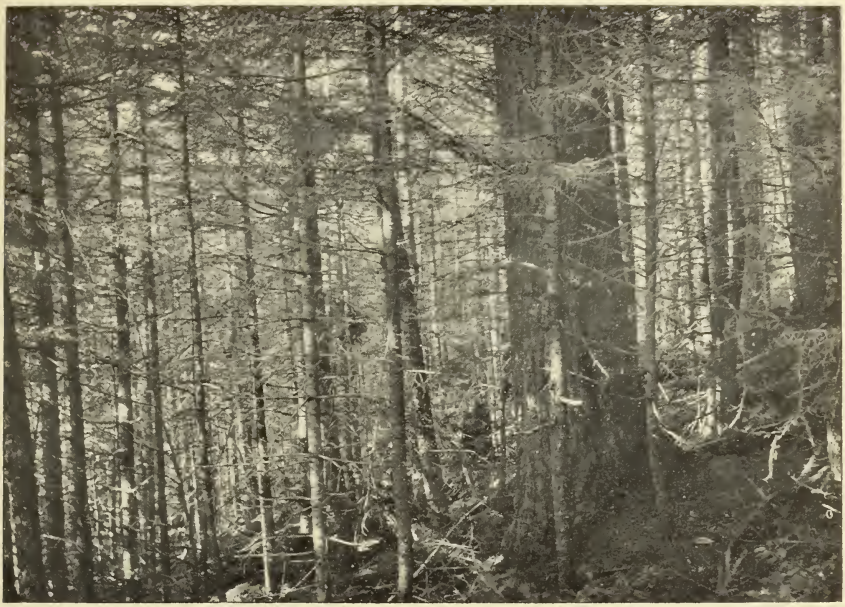

FIG. 1.—BALSAM UNDER HEMLOCK, TOWNSHIP 40.

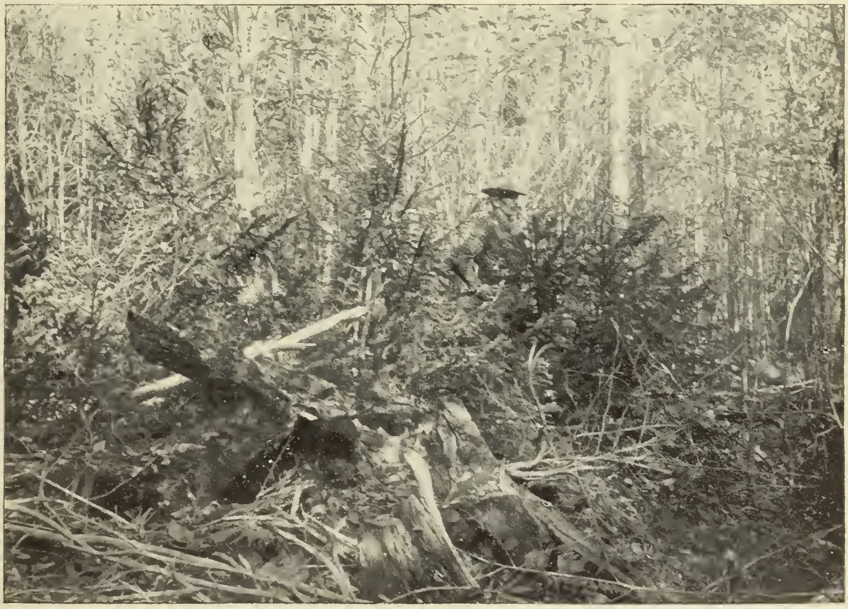

FIG. 2.—SPRUCE COMING IN AFTER ASPEN ON OLD BURN, WEST MOUNTAIN.

this more important than on steep upper slopes where the soil and ground cover are in danger of being washed away unless protected by forest growth.

To protect these upper slopes it is recommended that the part of Township 40 which has been classed as Upper Spruce Slope should not be lumbered. On account of the heavy winds to which these mountain slopes are exposed, the forest might as well be cut clean if cut at all in lumbering such areas. If only a portion of the trees were removed, those left standing would be in great danger from wind on account of the increased exposure. If a clean cutting were made, a long time must elapse before another crop could be obtained, and reproduction is likely to be rendered difficult.

The timber on these upper slopes is of minor value, because the cost of lumbering it would so nearly equal the returns that the margin of profit would be exceedingly low. Another side of the question, and one which is of importance at Raquette Lake, is that a clean cutting on the steep slopes would seriously mar the beauty of the mountains as seen from the lake.

For these reasons it is strongly recommended that nothing be done in the forests on the upper slopes. These areas appear on Map II as "Summit Watershed Reserve."

WATER FRONT RESERVE.

In order to preserve the beauty of Raquette Lake another reserve is recommended, on which no cutting should be allowed. This consists of a belt along the shores of the lake and of Marion River. It has a minimum width of 200 feet, and is frequently much wider, as a glance at Map II will show. All the islands belonging to the State and several of the large points have been included, while at certain points also the belt widens inland, as, for example, along the north side of Marion River, where it is made to include the large pines which add so much to the beauty of that bank.

With a reserve along the whole water front the beauty of Raquette Lake would be unimpaired by lumbering. To a casual observer all traces of cutting would be completely hidden, for the logging roads cut through to the lake would be so located, as is explained later in this working plan, that no "slash" would be visible from any part of the lake.

Map II shows the three forest types referred to in the three preceding tables (the Upper Spruce Slope and the Summit Watershed Reserve being identical) and the Water Front Reserve. It shows also all the private holdings within Township 40, as given in the "List of lands belonging to the Forest Preserve, 1897," a report of the Superintendent of State Forests. These private holdings have been left uncolored.

MERCHANTABLE FOREST AREA.

The Spruce Land and the Swamp types combined made the merchantable forest area, and it is with this portion of the tract that the working plan has to deal. As already said, the total area of Township 40 is 25,660 acres. The following statement shows the area of the water surfaces, various reserves, burns, etc.:

		Acres.
Raquette Lake and its islands, all streams, open marshes, and the Water Front Reserve		7,288
Private holdings		766
Summit Watershed Reserve and burned areas outside of reserves		710
Merchantable area—		
Spruce Land	14,919	
Swamp	1,977	
		16,896
Total		25,660

The following table presents the average results obtained on the 1,043 sample acres included in the entire merchantable area:

TABLE NO. 4.—*Merchantable area—Spruce Land and Swamp combined.*

[Average of 1,043 acres.]

(Sound trees 10 inches and over in diameter breasthigh.)

Name of species.	Average number of trees per acre.	Percentage of each species.	Average diameter breast-high.	Maximum diameter breast-high.
			Inches.	*Inches.*
Spruce	23.40	45.75	14.0	35
Birch	8.44	16.50	19.0	42
Beech	4.30	8.41	15.3	30
Hard Maple	3.47	6.78	15.1	32
Hemlock	4.43	8.66	17.7	47
Balsam	5.21	10.19	11.4	24
Soft Maple	.44	.86	16.1	31
White Pine	.48	.94	25.6	60
Cedar	.78	1.52	13.6	25
Other hardwoods	.20	.39	15.1	28
Average of all species	51.15	100.00	15.2	35.4
Average of all species except Spruce	27.75	54.25	16.2	35.4

THE ESTIMATE.

One of the most important steps in the preparation of a working plan is the measurement of standing timber and of the rate of growth of the more important trees. On these measurements are based tables giving the present stand and the future yield, and from them conclusions are drawn regarding the trees to be cut and the restrictions under which lumbering should be carried on. The method by which were obtained the necessary data on Township 40 for all the tables included in this working plan may now be described.

COMPARTMENTS.

To facilitate the estimate of standing timber, the township was divided into six compartments, depending on and following the natural divides. The advantage of a number of compartments of moderate size lies in the fact that the average acre more nearly represents the condition throughout the compartment than if the area were larger and more diversified in character. These compartments are shown by Roman numerals on Map III (p. 38). In dividing the township for lumbering purposes they fall naturally into three lumbering blocks, which, with the compartments, are fully described later in this working plan (p. 40).

VALUATION SURVEYS.

To estimate the standing timber on Township 40, valuation surveys were made. The object of a valuation survey is to ascertain the number of trees of the various kinds on sample acres, and their diameters. These sample acres are ordinarily strips one chain (66 feet) wide and 10 chains (660 feet) long. On Township 40 they were run on compass courses and so laid off at regular intervals and between definite points as thoroughly to gridiron it. They started from fixed stations about a quarter of a mile apart. Each survey party was made up of four men. Two carried the chain; one of these held the course and directed the party, while the other tallied the trees. A separate tally was kept for each acre. The other two men advanced to right and left of the chain, each measuring the diameter of the trees on his side within 33 feet of the chain. These measurements were obtained by calipers, and were taken at breastheight, or 4½ feet above the ground.

Red and Black Spruce and Balsam were calipered to 5 inches, and Pine, Hemlock, and the hardwoods to 10 inches, only sound trees being taken. One thousand and eighty valuation survey acres were measured on the township, distributed as follows among the forest types: Spruce Land, 953; Swamp, 90; Upper Spruce Slope, 37. Disregarding the Upper Spruce Slope, there are 1,043, so that for every 16 acres of merchantable forest land 1 acre has been measured.

Together with the valuation surveys, the height of the principal species was obtained by actual measurements with an instrument for that purpose known as Faustman's Hypsometer.

From the valuation surveys were obtained the number of trees per acre of the merchantable species, classified according to diameters by inches. From these diameter classes the merchantable yield per acre was obtained by the use of tables constructed from actual scales of felled trees, giving the volumes which correspond to the various diameters at breastheight. In this way it was easy to calculate the stand of each and of all merchantable species for each forest type, both on a given compartment and for the whole area.

VOLUME TABLES.

The contents of a tree of given diameter and height are got by the use of volume tables in conjunction with the valuation surveys. The tables have been prepared from measurements of numerous felled trees which have been carefully scaled. By counting on felled trees the annual rings of growth, and from other measurements, it has been possible to calculate their rate of growth in diameter and height and, consequently, in volume. Knowing the rate of growth of the timber trees and their number per acre as given by the surveys, the future yield after different periods and cutting to different diameter limits can be calculated.

In the preparation of the volume tables for this working plan, advantage was taken of lumbering which was in progress during 1900 on the Brandreth Preserve (Township 39), under the supervision of the Division of Forestry. Eleven hundred Spruce trees and 200 Hemlock were scaled. In calculating the contents of these Spruce in standards,[1] the trees were scaled to 6 inches in diameter at the small end. The advisability of this particular diameter limit will be discussed in detail later in this working plan (p. 56). As all stumps were cut low under the supervision of the Division of Forestry, it is believed that the volume table shows all that can be got from a tree of the given height and diameter. The volume was figured in standards by Dimick's Rule, the rule in common use in the Adirondacks.

The volume table for Balsam was obtained from a study of this species carried on by the Division of Forestry in the northern Adirondacks, the full results of which are to be published later.

The White Pine table was constructed from volume tables in "The White Pine,"[2] modified to accord with height and diameter measurements of the same species taken on Township 40. The volume tables for Yellow Birch, Hard Maple, and Beech were obtained from investigations of the Adirondack hardwoods made by the Division of Forestry in 1899. The hardwood volume tables are expressed in the Old Scribner Rule.

In calculating the merchantable volume of Cedar, the Spruce volume table was used, a reduction of 25 per cent being made on account of the difference in height and taper of the two species. The following table gives the contents on a basis of diameter at breastheight of all merchantable species, except Cedar, found on the township.

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[1] A standard is a log 13 feet long and 19 inches wide at the top end, containing approximately 195 feet B. M.

[2] "The White Pine," Pinchot and Graves. The Century Company, New York, 1896.

Table No. 5.—*Merchantable contents per tree*
For all marketable species except Cedar,
On a basis of diameter breasthigh.

Diameter breast-high.	Contents in standards by Dimick's Rule.				Contents in board feet by Old Scribner Rule.		
	Spruce.	White Pine.	Hem-lock.	Balsam.	Yellow Birch.	Hard Maple.	Beech.
Inches.							
6	0.15			0.06			
7	.20			.14			
8	.26			.20			
9	.33		0.16	.28			
10	.42	0.49	.33	.38			
11	.52	.60	.50	.50			
12	.65	.79	.68	.65			
13	.80	.97	.87	.82			
14	.97	1.19	1.07	1.00			
15	1.15	1.46	1.28	1.21	121	126	128
16	1.35	1.73	1.50	1.43	134	152	141
17	1.56	2.06	1.74	1.66	153	180	166
18	1.79	2.41	1.99		180	210	204
19	2.03	2.77	2.26		211	242	252
20	2.29	3.14	2.55		249	276	306
21	2.58	3.55	2.87		285	310	362
22	2.89	3.96	3.21		322	345	420
23	3.23	4.41	3.56		359	382	479
24	3.60	4.89	3.93		398	424	543
25	3.98	5.37	4.33		435	474	608
26	4.40	5.85	4.77		474	534	678
27	4.86	6.35	5.23		518	596	
28	5.36	6.89	5.70		564	670	
29	5.90	7.46	6.20		608	758	
30	6.48	8.03	6.72		658		
31		8.68	7.26		704		
32		9.31			757		
33		9.93			810		
34		10.59			866		
35		11.28					
36		12.06					
37		12.74					
38		13.64					
39		14.54					
40		15.44					

YIELD TABLES.

PRESENT STAND.

The following tables show the present stand of merchantable timber for the eight commercial trees growing on Township 40. They were compiled from the 1,043 acres of valuation surveys already mentioned and explained. In these tables the total stand for each compartment was found by multiplying the average stand got from the surveys by the number of acres in the compartment. The average stand was carried out to four decimal places and then multiplied by the acreage. In order, however, to simplify and shorten the table, two of these decimal places were taken off in the final figures, both for the total stand and the average stand per acre. This explains the fact that the product of the average stand multiplied by the total number of acres in the compartment varies slightly from the product as stated in the table. This variation is so small as to have no appreciable effect on the result.

The following table gives in standards by Dimick's Rule the present stand of Spruce on Township 40, to limits of 10, 12, and 14 inches at breastheight. The table shows also the total stand and the average stand per acre on each compartment for Spruce Land and Swamp, separately and combined.

TABLE NO. 6.—*Spruce—Present stand.*

[Merchantable volume in standards by Dimick's Rule.]

Number of compartment.	Type.	Acres.	Cutting to a limit of 10 inches in diameter breasthigh.		Cutting to a limit of 12 inches in diameter breasthigh.		Cutting to a limit of 14 inches in diameter breasthigh.	
			Average stand per acre.	Total stand.	Average stand per acre.	Total stand.	Average stand per acre.	Total stand.
I	Spruce Land	3,743	28.77	107,683.12	24.33	91,078.88	19.19	71,813.64
II	do	621	26.17	16,252.21	23.59	14,646.89	19.59	12,109.69
III	do	2,224	21.23	47,212.66	18.43	40,994.31	14.89	33,105.95
IV	do	2,678	20.47	54,811.93	17.13	45,878.48	13.79	35,942.74
V	do	4,798	23.14	111.001.81	19.51	93,590.42	15.81	75,876.60
VI	do	855	27.69	23,675.60	24.23	20,718.79	19.68	16,826.40
Total		14,919	24.17	360,637.33	20.57	306,907.77	16.53	246,675.02
I	Swamp	685	14.76	10,110.60	11.47	7.856.95	8.33	5,706.05
II	do	12	11.88	142.56	8.80	105.60	6.62	79.44
III	do	252	9.51	2,396.52	7.44	1,874.88	5.79	1,459.08
IV	do	595	13.60	8,092.00	11.03	6,562.85	8.43	5,015.85
V	do	433	14.36	6,217.88	11.50	4,979.50	9.28	4,018.24
Total		1,977	13.64	26,959.56	10.81	21,379.78	8.23	16,278.66
I	Spruce Land and Swamp combined.	4,428	26.60	117,793.72	22.34	98,935.83	17.51	77,519.69
II	do	633	25.90	16,394.77	23.31	14,752.49	19.26	12,189.13
III	do	2,476	20.04	49,609.18	17.31	42,869.19	13.96	34,565.03
IV	do	3,273	19.22	62,903.93	16.02	52,441.33	12.82	41,958.59
V	do	5,231	22.41	117,219.69	18.84	98,569.92	15.27	79,894.84
VI	do	855	27.69	23,675.60	24.23	20,718.79	19.68	16,826.40
Total		16,896	22.94	387,596.89	19.43	328,287.55	15.56	262,953.68

The following table gives in standards by Dimick's Rule the present stand of Balsam on Township 40, to limits of 10, 12, and 14 inches in diameter breasthigh. The table shows, also, the total stand and the average stand per acre on each compartment for Spruce Land and Swamp, separately and combined.

TABLE NO. 7.—*Balsam—Present stand.*

[Merchantable volume in standards by Dimick's Rule.]

Number of compartment.	Type.	Acres.	Cutting to a limit of 10 inches in diameter breasthigh.		Cutting to a limit of 12 inches in diameter breasthigh.		Cutting to a limit of 14 inches in diameter breasthigh.	
			Average stand per acre.	Total stand.	Average stand per acre.	Total stand.	Average stand per acre.	Total stand.
I	Spruce Land	3,743	2.32	8,684.51	1.10	4,111.31	0.40	1,481.11
II	do	621	1.06	655.96	.50	311.31	.20	126.13
III	do	2,224	3.49	7,759.09	1.84	4,102.39	.69	1,537.45
IV	do	2,678	4.42	11,845.87	2.35	6,282.05	.88	2,363.87
V	do	4,798	2.65	12,730.05	1.46	6.981.09	.66	3,184.91
VI	do	855	1.96	1,672.81	1.18	1,012.75	.40	344.22
Total		14,919	2.91	43,348.29	1.53	22.800.90	.61	9,037.69

TABLE No. 7.—*Balsam—Present stand*—Continued.

Number of compartment.	Type.	Acres.	Cutting to a limit of 10 inches in diameter breasthigh.		Cutting to a limit of 12 inches in diameter breasthigh.		Cutting to a limit of 14 inches in diameter breasthigh.	
			Average stand per acre.	Total stand.	Average stand per acre.	Total stand.	Average stand per acre.	Total stand.
I	Swamp	685	6.25	4,284.54	2.35	1,608.11	.83	568.00
II	do	12	.79	9.48	.41	4.92	.41	4.92
III	do	252	2.46	620.42	1.38	347.00	.77	192.78
IV	do	595	5.05	3,003.86	2.49	1,479.59	.70	413.70
V	do	433	6.12	2,651.52	2.48	1,075.40	.57	245.08
Total		1,977	5.35	10,569.82	2.28	4,515.02	.72	1,424.48
I	Spruce Land and Swamp combined	4,428	2.93	12,969.05	1.29	5,719.42	.46	2,049.11
II	do	633	1.05	665.44	.50	316.23	.21	131.05
III	do	2,476	3.38	8,379.51	1.80	4,449.39	.70	1,730.23
IV	do	3,273	4.54	14,849.73	2.37	7,761.64	.85	2,777.57
V	do	5,231	2.94	15,381.57	1.54	8,056.49	.66	3,429.99
VI	do	855	1.96	1,672.81	1.18	1,012.75	.40	344.22
Total		16,896	3.19	53,918.11	1.62	27,315.92	.62	10,462.17

The following table gives in standards by Dimick's Rule the present stand of small Balsam from 6 to 9 inches, inclusive, in diameter breasthigh. The table shows also the total stand and the average stand per acre on each compartment for Spruce Land and Swamp, separately and combined.

TABLE No. 8.—*Small Balsam—Present stand.*

[Merchantable volume in standards by Dimick's Rule of trees 6 to 9 inches, inclusive, in diameter breasthigh.]

Number of compartment.	Type.	Acres.	Average stand per acre.	Total stand.
I	Spruce Land	3,743	1.91	7,164.10
II	do	621	.91	566.23
III	do	2,224	3.14	6,982.47
IV	do	2,678	3.36	9,008.79
V	do	4,798	1.70	8,165.24
VI	do	855	1.03	884.58
Total		14,919	2.20	32,771.41
I	Swamp	685	9.05	6,199.52
II	do	12	2.81	33.72
III	do	252	5.98	1,505.95
IV	do	595	6.74	4,008.52
V	do	433	6.54	2,832.17
Total		1,977	7.37	14,579.88
I	Spruce Land and Swamp combined	4,428	3.02	13,363.62
II	do	633	.95	599.95
III	do	2,476	3.43	8,488.42
IV	do	3,273	3.98	13,017.31
V	do	5,231	2.10	10,997.41
VI	do	855	1.03	884.58
Total		16,896	2.80	47,351.29

The following table gives in standards by Dimick's Rule the present stand of Pine on Township 40, to limits of 10, 12, and 14 inches in diameter breasthigh. In this table "Pine Land" includes that portion of each compartment upon which the stand of Pine is heavy enough to be considered. Seventy-six per cent of the merchantable area is so classed.

TABLE NO. 9.—*Pine—Present stand.*

[Merchantable volume in standards by Dimick's Rule.]

Number of compartment.	Type.	Acres.	Cutting to a limit of 10 inches in diameter breasthigh.		Cutting to a limit of 12 inches in diameter breasthigh.		Cutting to a limit of 14 inches in diameter breasthigh.	
			Average stand per acre.	Total stand.	Average stand per acre.	Total stand.	Average stand per acre.	Total stand.
I	Pine Land	2,533	4.87	12,342.97	4.87	12,328.41	4.86	12,312.05
II	do	500	1.54	772.00	1.50	750,70	1.50	750.70
III	do	1,920	4.04	7,757.84	4.00	7,673.17	3.93	7,548.34
IV	do	3,273	1.05	3,435.23	1.05	3,435.23	1.05	3,435.23
V	do	3,768	1.07	4,022.84	1.07	4,022.84	1.05	3,951.14
VI	do	855	.07	60.30	.07	60.30	.07	60.30
Total		12,849	2.21	28,391.18	2.20	28,270.65	2.18	28,057.76

The following table gives in standards by Dimick's Rule the present stand of Cedar on Township 40 to limits of 10, 12, and 14 inches in diameter breasthigh. The table shows also the total stand and the average stand per acre on each compartment for Spruce Land and Swamp, separately and combined.

TABLE NO. 10.—*Cedar—Present stand.*

[Merchantable volume in standards by Dimick's Rule.]

Number of compartment.	Type.	Acres.	Cutting to a limit of 10 inches in diameter breasthigh.		Cutting to a limit of 12 inches in diameter breasthigh.		Cutting to a limit of 14 inches in diameter breasthigh.	
			Average stand per acre.	Total stand.	Average stand per acre.	Total stand.	Average stand per acre.	Total stand.
I	Spruce Land	3,743	0.14	540.92	0.12	442.39	0.08	304.27
II	do	621	.35	215.98	.29	179.29	.27	165.88
III	do	2,224	.03	74.59	.03	56.37	.03	56.37
IV	do	2,678	.74	1,983.25	.66	1,757.25	.51	1,373.23
V	do	4,798	.08	401.30	.08	366.39	.06	305.58
VI	do	855	.65	557.66	.58	497.30	.42	365.33
Total		14,919	.25	3,773.72	.22	3,299.03	.17	2,570.69
I	Swamp	685	.24	162.96	.12	83.82	.03	23.63
II	do	12	26.98	323.73	23.73	284.76	18.35	220.18
III	do	252	.65	163.29	.51	128.70	.27	67.76
IV	do	595	5.69	3,387.66	4.70	2,794.12	3.63	2,161.92
V	do	433	6.42	2,781.41	5.05	2,187.25	3.27	1,415.65
Total		1,977	3.45	6,819.06	2.77	5,478.07	1.97	3,889.14
I	Spruce Land and Swamp combined	4,428	.16	703.88	.12	525.62	.07	327.90
II	do	633	.85	539.71	75	464.05	.61	386.01
III	do	2,476	.10	237.88	.07	185.08	,05	124.13
IV	do	3,273	1.64	5,370.92	1.39	4,551.38	1.08	3,535.15
V	do	5,231	.61	3,182.72	.49	2,553.65	.33	1,721.23
VI	do	855	.65	557.66	.58	497.30	.43	365.33
Total		16,896	.63	10,592.79	.52	8,777.10	.38	6,459.83

The following table gives in standards by Dimick's Rule the present stand of Hemlock on Township 40 to limits of 10, 12, and 14 inches in diameter breasthigh. The table shows also the total stand and the average stand per acre on each compartment for Spruce Land and Swamp, separately and combined.

TABLE NO. 11.—*Hemlock—Present stand.*

[Merchantable volume in standards by Dimick's Rule.]

Number of compartment.	Type.	Acres.	Cutting to a limit of 10 inches in diameter breasthigh.		Cutting to a limit of 12 inches in diameter breasthigh.		Cutting to a limit of 14 inches in diameter breasthigh.	
			Average stand per acre.	Total stand.	Average stand per acre.	Total stand.	Average stand per acre.	Total stand.
I	Spruce Land	3,743	5.74	21,475.84	5.54	20,730.98	5.24	19,596.85
II	do	621	18.36	11,399.95	17.86	11,090.56	16.74	10,398.15
III	do	2,224	7.80	17,355.65	7.51	16,695.12	6.94	15,432.34
IV	do	2,678	15.95	42,707.41	15.46	41,396.52	14.61	39,122.37
V	do	4,798	10.32	49,502.89	9.85	47,256.94	9.14	43,872.43
VI	do	855	2.59	2,215.31	2.55	2,178.37	2.39	2,040.71
Total		14,919	9.69	144,657.05	9.34	139,348.49	8.74	130,462.85
I	Swamp	685	.52	354.00	.45	311.27	.38	259.75
II	do	12	7.42	89.04	6.01	72.06	4.89	58.68
III	do	252	1.08	271.78	1.04	261.32	.66	165.06
IV	do	595	4.09	2,433.43	3.77	2,240.18	3.26	1,937.44
V	do	433	3.98	1,721.78	3.70	1,601.06	3.19	1,379.71
Total		1,977	2.46	4,870.03	2.27	4,485.89	1.92	3,800.64
I	Spruce Land and Swamp combined	4,428	4.93	21,829.84	4.75	21,042.25	4.48	19,856.60
II	do	633	18.15	11,488.99	17.63	11,162.62	16.52	10,456.83
III	do	2,476	7.12	17,627.43	6.85	16,956.44	6.30	15,597.40
IV	do	3,273	13.79	45,140.84	13.33	43,636.70	12.55	41,059.81
V	do	5,231	9.79	51,224.67	9.34	48,858.00	8.65	45,252.14
VI	do	855	2.59	2,215.31	2.55	2,178.37	2.39	2,040.71
Total		16,896	8.85	149,527.08	8.51	143,834.38	7.94	134,263.49

The following table gives in board feet by Old Scribner Rule the present stand of Birch on Township 40, to limits of 15, 17, and 19 inches in diameter breasthigh. The table shows also the total stand and the average stand per acre on each compartment for Spruce Land and Swamp, separately and combined.

TABLE NO. 12—*Birch—Present stand.*

[Merchantable volume in board-feet by Old Scribner Rule.]

Number of compartment.	Type.	Acres.	Cutting to a limit of 15 inches in diameter breasthigh.		Cutting to a limit of 17 inches in diameter breasthigh.		Cutting to a limit of 19 inches in diameter breasthigh.	
			Average stand per acre.	Total stand.	Average stand per acre.	Total stand.	Average stand per acre.	Total stand.
I	Spruce Land	3,743	1,964	7,350,810	1,722	6,447,179	918	3,437,243
II	do	621	2,118	1,315,105	1,949	1,210,287	1,706	1,059,217
III	do	2,224	1,710	3,802,996	1,559	3,466,660	1,334	2,967,061
IV	do	2,678	1,460	3,908,742	1,308	3,503,844	1,112	2,977,216
V	do	4,798	1,785	8,566,114	1,629	7,814,344	1,414	6,784,065
VI	do	855	2,190	1,872,822	2,036	1,740,588	1,812	1,549,237
Total		14,919	1,797	26,816,589	1,621	24,182,902	1,258	18,774,039

TABLE No. 12—*Birch—Present stand*—Continued.

Number of compartment.	Type.	Acres.	Cutting to a limit of 15 inches in diameter breasthigh.		Cutting to a limit of 17 inches in diameter breasthigh.		Cutting to a limit of 19 inches in diameter breasthigh.	
			Average stand per acre.	Total stand.	Average stand per acre.	Total stand.	Average stand per acre.	Total stand.
I	Swamp	685	339	232,133	223	153,029	185	126,396
II	do	12	670	8,046	670	8,046	441	5,292
III	do	252	119	29,988	106	26,775	73	18,383
IV	do	595	276	164,041	197	117,043	133	78,948
V	do	433	434	187,801	387	167,363	275	119,040
Total		1,977	315	622,009	239	472,256	176	348,059
I	Spruce Land and Swamp combined	4,428	1,712	7,582,943	1,491	6,600,208	1,256	5,563,639
II	do	633	2,090	1.323,151	1,925	1,218,333	1,682	1,064,509
III	do	2,476	1,548	3,832,984	1,411	3,493,435	1,206	2,985,444
IV	do	3,273	1,244	4,072,783	1,106	3,620,887	934	3,056,164
V	do	5,231	1,673	8,753,915	1,526	7,981,707	1,320	6,903,105
VI	do	855	2,190	1,872,822	2,036	1,740,588	1,812	1,549,237
Total		16,896	1,624	27,438,598	1,459	24,655,158	1,132	19,122,098

The following table gives in board feet by Old Scribner Rule the present stand of Hard Maple on Township 40, to limits of 15, 17, and 19 inches in diameter breasthigh. This table shows also the total stand and the average stand per acre on each compartment for Spruce Land and Swamp, separately and combined.

TABLE No. 13.—*Hard Maple—Present stand.*

[Merchantable volume in board feet by Old Scribner Rule.]

Number of compartment.	Type.	Acres.	Cutting to a limit of 15 inches in diameter breasthigh.		Cutting to a limit of 17 inches in diameter breasthigh.		Cutting to a limit of 19 inches in diameter breasthigh.	
			Average stand per acre.	Total stand.	Average stand per acre.	Total stand.	Average stand per acre.	Total stand.
I	Spruce Land	3,743	452	1,691,260	356	1,333,938	258	966,750
II	do	621	983	610,276	870	540,272	692	429,889
III	do	2,224	1,008	2,242,192	791	1,758,250	607	1,350,924
IV	do	2,678	486	1,302,354	381	1,021,186	267	713,885
V	do	4,798	500	2,397,647	383	1,836,271	275	1,317,224
VI	do	855	325	277,838	232	198,687	149	127,329
Total		14,919	571	8,521,567	448	6,688,604	329	4,906,001
I	Swamp	685	41	27,838	19	13,316	11	7,562
II	do	12	76	912				
III	do	252	13	3,175				
IV	do	595						
V	do	433	27	11,570	16	6,755		
Total		1,977	22	43,495	10	20,071	4	7,562
I	Spruce Land and Swamp combined	4,428	388	1,719,098	304	1,347,254	220	974,312
II	do	633	966	611,188	854	540,272	679	429,889
III	do	2,476	907	2,245,367	710	1,758,250	546	1,350,924
IV	do	3,273	398	1,302,354	312	1,021,186	218	713,885
V	do	5,231	461	2,409,217	352	1,843,026	252	1,317,224
VI	do	855	325	277,838	232	198,687	149	127,329
Total		16,896	507	8,565,062	397	6,708,675	291	4,913,563

The following table gives in board feet by Old Scribner Rule the present stand of Beech on Township 40, to limits of 15, 17, and 19 inches in diameter breasthigh. The table shows also the total stand and the average stand per acre on each compartment for Spruce Land and Swamp, separately and combined.

TABLE No. 14.—*Beech—Present stand.*

[Merchantable volume in board feet by Old Scribner Rule.]

Number of compartment.	Type.	Acres.	Cutting to a limit of 15 inches in diameter breasthigh.		Cutting to a limit of 17 inches in diameter breasthigh.		Cutting to a limit of 19 inches in diameter breasthigh.	
			Average stand per acre.	Total stand.	Average stand per acre.	Total stand.	Average stand per acre.	Total stand.
I	Spruce Land	3,743	504	1,887,277	342	1,279,028	199	746,594
II	do	621	636	394,970	432	268,549	256	159,047
III	do	2,224	513	1,140,140	325	722,849	182	405,520
IV	do	2,678	269	720,754	172	461,816	100	268,020
V	do	4,798	477	2,287,490	323	1,547,902	182	873,034
VI	do	855	312	266,516	178	151,841	78	66,904
Total		14,919	448	6,697,147	297	4,431,985	168	2,519,119
I	Swamp	685						
II	do	12						
III	do	252						
IV	do	595						
V	do	433	5	2,217				
Total		1,977	1	2,217				
I	Spruce Land and Swamp combined	4,428	426	1,887,277	289	1,279,028	169	746,594
II	do	633	624	394,970	424	268,549	251	159,047
III	do	2,476	460	1,140,140	292	722,849	164	405,520
IV	do	3,273	220	720,754	141	461,816	82	268,020
V	do	5,231	438	2,289,707	296	1,547,902	167	873,034
VI	do	855	312	266,516	178	151,841	78	66,904
Total		16,896	397	6,699,364	262	4,431,985	149	2,519,119

The following table is a summary of Tables Nos. 6, 7, and 9, which give the present stand of Spruce, Balsam, and Pine:

TABLE No. 15.—*Softwoods—Present stand.*

[Total merchantable volume of Spruce, Balsam, and Pine on Township 40, in standards by Dimick's Rule.]

Number of compartment.	Acres.	Cutting to a limit of 10 inches in diameter breasthigh.	
		Average stand per acre.	Total stand.
I	4,428	32.32	143,105.74
II	633	28.17	17,832.21
III	2,476	26.55	65,746.53
IV	3,273	24.81	81,188.89
V	5,231	26.12	136,624.10
VI	855	29.72	25,408.71
Total	16,896	27.81	469,906.18

TABLE No. 15.—*Softwoods—Present stand*—Continued.

Number of compartment.	Acres.	Cutting to a limit of 12 inches in diameter breasthigh.	
		Average stand per acre.	Total stand.
I	4,428	26.42	116,983.66
II	633	24.99	15,819.42
III	2,476	22.21	54,991.75
IV	3,273	19.44	63,638.20
V	5,231	21.15	110,649.25
VI	855	25.49	21,791.84
Total	16,896	22.72	383,874.12

Number of compartment.	Acres.	Cutting to a limit of 14 inches in diameter breasthigh.	
		Average stand per acre.	Total stand.
I	4,428	20.75	91,880.85
II	633	20.65	13,070.88
III	2,476	17.71	43,843.60
IV	3,273	14.72	48,171.39
V	5,231	16.69	87,275.97
VI	855	20.15	17,230.92
Total	16,896	17.84	301,473.61

The following table is a summary of Tables Nos. 12, 13, and 14, which give the present stand of Birch, Maple, and Beech:

TABLE No. 16.—*Hardwoods—Present stand.*

[Total merchantable volume of Birch, Maple, and Beech on Township 40, in standards by Dimick's Rule and in board feet by Old Scribner Rule.]

Number of compartment.	Acres.	Cutting to a limit of 15 inches in diameter breasthigh.			
		Average stand per acre.		Total stand.	
		Standards.	Board feet.	Standards.	Board feet.
I	4,428	12.96	2,527	57,381	11,189,318
II	633	18.87	3,680	11,945	2,329,309
III	2,476	14.95	2,915	37,018	7,218,491
IV	3,273	9.55	1,862	31,261	6,095,891
V	5,231	13.19	2,572	68,989	13,452,839
VI	855	14.50	2,827	12,396	2,417,176
Total	16,896	12.96	2,527	218,990	42,703,024

Number of compartment.	Acres.	Cutting to a limit of 17 inches in diameter breasthigh.			
		Average stand per acre.		Total stand.	
		Standards.	Board feet.	Standards.	Board feet.
I	4,428	10.69	2,084	47,315	9,226,490
II	633	16.42	3,202	10,396	2,027,154
III	2,476	12.37	2,413	30,639	5,974,534
IV	3,273	8.00	1,559	26,174	5,103,889
V	5,231	11.15	2,174	58,321	11,372,635
VI	855	12.54	2,446	10,724	2,091,116
Total	16,896	10.86	2,119	183,569	35,795,818

TABLE No. 16.—*Hardwoods—Present stand*—Continued.

Number of compartment.	Acres.	Cutting to a limit of 19 inches in diameter breasthigh.			
		Average stand per acre.		Total stand.	
		Standards.	Board feet.	Standards.	Board feet.
I	4,428	8.44	1,645	37,357	7,284,545
II	633	13.40	2,612	8,479	1,653,445
III	2,476	9.82	1,915	24,317	4,741,888
IV	3,273	6.33	1,234	20,708	4,038,069
V	5,231	8.91	1,738	46,633	9,093,363
VI	855	10.46	2,039	8,941	1,743,470
Total	16,896	8.67	1,690	146,435	28,554,780

FUTURE STAND OF SPRUCE.

A study of the rate of growth of Spruce has been made by the Division of Forestry in several parts of the Adirondacks, in both cut-over and virgin forest. Similar measurements of growth were made on Township 39, under forest conditions closely resembling those on Township 40. By means of these measurements it was possible to select from the several tables compiled by the Division of Forestry, showing the rate of growth of Spruce, that which applies most closely to the Spruce upon Township 40. The table chosen and given below was made from measurements taken at Tahawus, Essex County, New York, on land where the conditions of growth of Spruce were sufficiently similar to those on Township 40 to make safe its application to that tract. The increased increment which followed the opening of the forest by lumbering has been disregarded, in order to insure a thoroughly safe and conservative estimate. The table chosen was compiled from analyses of 461 trees.

The following table shows the average annual increase in diameter for Spruce of various sizes, and the number of years required to grow 1 inch:

TABLE No. 17.—*Rate of growth in diameter of Spruce.*

Diameter breast-high.	Annual growth.	Time required to grow 1 inch.
Inches.	*Inches.*	*Years.*
3	0.0460	22
4	.0605	17
5	.0718	14
6	.0825	12
7	.0933	11
8	.1040	10
9	.1150	9
10	.1260	8
11	.1350	7
12	.1425	7
13	.1485	7
14	.1545	6
15	.1595	6
16	.1645	6
17	.1685	6
18	.1725	6

The following table has been constructed from Table No. 17, and shows the growth in diameter to be expected in trees of 4 to 13 inches, breasthigh, in periods ranging by decades from 10 to 60 years:

TABLE NO. 18.—*Growth in diameter of Spruce by 10-year periods.*

Present diameter breast-high.	Diameter breast-high after 10 years.	Diameter breast-high after 20 years.	Diameter breast-high after 30 years.	Diameter breast-high after 40 years.	Diameter breast-high after 50 years.	Diameter breast-high after 60 years.
Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
4	----------	----------	----------	----------	----------	8.62
5	----------	----------	----------	8.31	9.35	10.50
6	----------	----------	8.73	9.80	11.00	12.43
7	----------	8.94	10.00	11.27	12.71	14.15
8	9.00	10.13	11.40	12.86	14.31	16.00
9	10.13	11.40	12.86	14.31	16.00	17.67
10	11.27	12.71	14.15	15.80	17.51	----------
11	12.43	13.89	15.48	17.17	18.87	----------
12	13.45	15.00	16.66	18.34	----------	----------
13	14.46	16.16	17.84	----------	----------	----------

Knowing from the valuation surveys the number of trees per acre of various diameters down to 5 inches, breasthigh, the future stand may be calculated by the use of Table No. 18. For purposes of comparison, the yield which might be obtained in the next five decades if the present cut were made to a diameter limit of 10, 12, or 14 inches, breasthigh, respectively, has been calculated. The following table shows the yields of Spruce which might be obtained after successive ten-year periods on Township 40, expressed in standards, and the number of years which must elapse before an equal cut can be obtained, provided the same diameter limit is adhered to at that time:

TABLE NO. 19.—*Estimate of future yield per acre of Spruce on merchantable area.*

Cutting limit: diameter breast-high.	Average present stand per acre.	Average cut per acre obtainable at the end of ten-year periods, in standards.					Interval required between equal cuts.
		10	20	30	40	50	
Inches.	*Standards.*						*Years.*
10	22.94	1.90	5.20	10.00	16.10	24.20	50
12	19.43	2.20	6.20	12.40	20.70	--------	39
14	15.56	3.80	9.20	16.60	--------	--------	29

The following table shows, in percentages of the present cut to the three diameter limits, what the future cuts will be in from ten to fifty years:

TABLE NO. 20.—*Future cuts of Spruce, expressed in percentages of present stand.*

Cutting limit: diameter breast-high.	Average present stand per acre.	Average cut per acre obtainable at the end of ten-year periods, expressed in percentages of present stand.					Interval required between equal cuts.
		10	20	30	40	50	
Inches.	*Standards.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Years.*
10	22.94	8.3	22.7	43.7	70.3	105.7	50
12	19.43	11.3	32.0	63.9	106.6	--------	39
14	15.56	24.4	59.0	106.4	--------	--------	29

Table No. 21 shows the total future yield of Spruce to be expected from the merchantable area of Township 40, in from ten to fifty years, after cutting to 10, 12, or 14 inches.

TABLE NO. 21.—*Estimate of total future yield of Spruce on merchantable area.*

Cutting limit: diameter breast-high.	Total present stand.	Total yield per acre obtainable at the end of ten-year periods, in standards.					Interval required between equal cuts.
		10	20	30	40	50	
Inches.	*Standards.*						*Years.*
10	387,596.89	32,102.40	87,859.20	168,960.00	272,025.60	408,883.20	50
12	328,287.56	37,171.20	104,755.20	209,510.40	349,747.20	--------------	39
14	262,953.68	64,204.80	155,443.20	280,473.60	--------------	--------------	29

It will be seen from these tables that if 10 inches be adopted as the present diameter limit, almost fifty years must elapse before an equal cut can again be obtained. The rotation with a 12-inch limit is thirty-nine years, while if 14 inches be chosen, twenty-nine years will be the interval between equal cuts. A comparison of the amounts to be obtained shows that it is more profitable to cut to a 12-inch limit than to a 10-inch limit, and also that cutting to 14 inches will yield more in the long run than cutting to 12 inches. The present yield to a 14-inch limit is not, however, large enough to justify the construction of logging roads, the building of camps, the improvement of streams, and the meeting of other expenses necessary for lumbering. Cutting to 12 inches the present yield is 19.43 standards per acre, an amount sufficiently large to make sure a margin of profit in lumbering. With a 12-inch limit the trees of large size which have reached their maturity would be removed, with a consequent benefit to the remaining growth and to the forest, while a sufficient number of seed trees would be left to insure the reproduction of Spruce.

A diameter limit of 12 inches is preferable to a smaller limit, because a larger number of seed trees would be left standing and the chances for the reproduction of the Spruce would be proportionately increased. Moreover, cutting to 10 inches would remove many trees which although old are still thrifty, and which, after the first cutting, will add to their merchantable contents far more rapidly than would those smaller trees which would remain if a lower diameter limit were fixed. The more conservative limit will also protect the watersheds better and minimize the damage to the forest from lumbering. It is believed, therefore, for the several reasons above stated, that 12 inches will be preferable to any other diameter limit to which to cut the Spruce. It must be clearly understood, however, that this diameter limit is subject to local modification at the discretion of the man who marks the trees. It is not an arbitrary figure, but merely an average to aid in fixing the yield and in marking the trees to be cut. It will, under certain conditions, be necessary for the good of the forest to leave Spruce of over 12 inches and to cut trees below 12 inches in diameter.

Table No. 22 is constructed from Table No. 21, and shows what will be the money returns of future cuts of Spruce in from ten to fifty years, at 40, 50, and 60 cents per standard. It is not intended to be more than an approximation; but, assuming that the present prices will obtain in the future, it shows the returns to be expected.

TABLE NO. 22.—*Estimate of future returns from Spruce stumpage on merchantable area at the end of ten-year periods.*

STUMPAGE AT 40 CENTS PER STANDARD.

Cutting limit: diameter breast-high.	Present value.	10	20	30	40	50
Inches.						
10	$155,039	$12,841	$35,144	$67,584	$108,810	$163,553
12	131,315	14,868	41,902	83,804	139,899	....
14	105,181	25,682	62,177	112,189	....	....

STUMPAGE AT 50 CENTS PER STANDARD.

10	$193,798	$16,051	$43,930	$84,480	$136,013	$204,442
12	164,144	18,586	52,378	104,755	174,874	....
14	131,477	32,102	77,722	140,237	....	....

STUMPAGE AT 60 CENTS PER STANDARD.

10	$232,558	$19,261	$52,716	$101,376	$163,215	$245,330
12	196,973	22,303	62,853	125,706	209,848	....
14	157,772	38,523	93,266	168,284	....	....

SPECIES TO BE LUMBERED.

SPRUCE, BALSAM, AND PINE.

While estimates have been given for eight species, it is advised that lumbering should be restricted for the present to Spruce, Balsam, and Pine. As has been stated under "Future Stand of Spruce," the diameter limit to which the Spruce should be cut, under the present plan, has been fixed at 12 inches breasthigh.

In Table No. 7 the stand of Balsam has been given for trees 10 inches and over in diameter breasthigh, and in Table No. 8 for trees 6 to 9 inches breasthigh. The stand to 10 inches is 16.4 per cent of the total stand of Spruce to 12 inches. Since in lumbering it is customary to put in 15 per cent of Balsam with the Spruce, it would reach this amount for the whole tract if cut to 10 inches only. Should it be possible, however, to lumber more Balsam than is necessary to make 15 per cent of the Spruce, the total merchantable stand might be taken, except in those few localities designated by the inspector where the local conditions require that clean cutting should not be made. Balsam being one of the inferior trees, the condition of the forest would be rather improved than injured by its removal, since more room would be made for the more valuable species.

As is shown in the preceding tables, the first-growth White Pine on Township 40 is mostly mature, almost all the trees being of large size. These Pines should be lumbered except within the reserve belt along the banks of the lakes and rivers. A 14-inch diameter limit is recommended because trees of this size are merchantable and should come out, and because cutting to this limit will leave a certain number of trees for seed. Cutting to 14 inches will yield an amount of Pine equal to 8 per cent of the cut of Spruce to 12 inches.

These diameter limits for Spruce, Balsam, and Pine refer, as has been stated, to the diameter breasthigh, or 4½ feet from the ground. These limits must not be confounded with what the diameter would be at the cutting point on the stump, as the following table shows.

The figures used in constructing this table were determined by 2,624 measurements taken on this tract and upon Township 39, where lumbering has been carried on under the supervision of the Division of Forestry during the past summer (1900). The work was done under watchful inspection and according to the rules of the Division for lumbering, and all stumps were cut at the lowest practicable point. The measurements were very carefully taken, and the results may be relied upon for Spruce.

TABLE NO. 23.—*Comparative average diameters of Spruce.*

At breast-height.	At lowest practicable cutting point.	At top of root swelling.	At breast-height.	At lowest practicable cutting-point.	At top of root swelling.
Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
10	11.9	13.0	21	24.1	25.9
11	13.0	14.1	22	25.3	27.1
12	14.1	15.3	23	26.4	28.2
13	15.2	16.5	24	27.5	29.4
14	16.3	17.7	25	28.6	30.6
15	17.4	18.8	26	29.7	31.7
16	18.5	20.0	27	30.9	32.9
17	19.7	21.2	28	32.0	34.0
18	20.8	22.4	29	33.1	35.2
19	21.9	23.5	30	34.2	36.4
20	23.0	24.7			

The increasing difference between the diameter at breastheight, at the cutting point, and at the top of the root swelling, is explained by the fact that on the larger trees the swelling of the roots reaches higher, and consequently increases the diameter at the top of the root swelling in comparison with the diameter breasthigh. Thus, the larger the tree the greater the taper from the top of the root swelling to breastheight. For a discussion of the cutting point see page 55.

The same general proportion shown by this table applies to Balsam and Pine.

The following table shows the stand of Spruce to 12 inches, Balsam to 10 inches, and Pine to 14 inches breasthigh, with the totals for the merchantable area in the several compartments. It must be borne in mind that Pine Land is not distinct from Spruce Land and Swamp, but is that part of them in which Pine forms any considerable portion of the growth.

Table No. 24.—*Present stand of Spruce 12 inches and over, Balsam 10 inches and over, and Pine 14 inches and over breasthigh, on each compartment of Township 40.*

Number of compartment.	Species.	Type.	Acres.	Merchantable volume.			
				Standards by Dimick's Rule.		Board feet by Old Scribner Rule.	
				Average stand per acre.	Total stand.	Average stand per acre	Total stand.
I	Spruce	Spruce Land and Swamp.	4,428	22.34	98,935.83	4,356	19,292,487
	Balsam			2.93	12,969.05	571	2,528,964
	Pine	Pine Land	2,533	4.86	12,312.05	948	2,400,850
	Total		4,428	28.05	124,216.93	5,470	24,222,301
II	Spruce	Spruce Land and Swamp.	633	23.31	14,752.49	455	2,876,736
	Balsam			1.05	665.44	205	129,761
	Pine	Pine Land	500	1.50	750.70	293	146,386
	Total		633	25.54	16,168.63	4,980	3,152,883
III	Spruce	Spruce Land and Swamp.	2,476	17.31	42,869.19	3,375	8,359,492
	Balsam			3.38	8,379.51	659	1,634,004
	Pine	Pine Land	1,920	3.93	7,548.34	766	1,471,926
	Total		2,476	23.75	58,797.04	4,631	11,465,422
IV	Spruce	Spruce Land and Swamp.	3,273	16.02	52,441.33	3,124	10,226,059
	Balsam			4.54	14,849.73	885	2,895,697
	Pine	Pine Land	3,273	1.05	3,435.23	205	669,870
	Total		3,273	21.61	70,726.29	4,214	13,791,626
V	Spruce	Spruce Land and Swamp.	5,231	18.84	98,569.92	3,674	19,221,134
	Balsam			2.94	15,381.57	573	2,999,406
	Pine	Pine Land	3,768	1.05	3,951.14	205	770,472
	Total		5,231	22.54	117,902.63	4,395	22,991,012
VI	Spruce	Spruce Land and Swamp.	855	24.23	20,718.79	4,725	4,040,164
	Balsam			1.96	1,672.81	382	326,198
	Pine	Pine Land	855	.07	60.30	14	11,759
	Total		855	26.26	22,451.90	5,121	4,378,121
	Spruce	Spruce Land and Swamp.	16,896	19.43	328,287.55	3,789	64,016,072
	Balsam			3.19	53,918.11	622	10,514,030
	Pine	Pine Land	12,849	2.18	28,057.76	425	5,471,263
	Total		16,896	24.28	410,263.42	4,735	80,001,367

Table No. 25 shows the present stand of Spruce 12 inches and over, Balsam 10 inches and over, and Pine 14 inches and over breasthigh, on the three lumbering blocks of Township 40. (See Map III.)

Table No. 25.—*Present stand of Spruce, Balsam, and Pine by lumbering blocks.*

Number of block.	Number of compartment.	Species.	Type.	Acres.	Merchantable volume.			
					Standards by Dimick's Rule.		Board feet by Old Scribner Rule.	
					Average stand per acre.	Total stand.	Average stand per acre.	Total stand.
1	I	Spruce	Spruce Land and Swamp.	4,428	22.34	98,935.83	4,356	19,292,487
		Balsam			2.93	12,969.05	571	2,528,964
		Pine	Pine Land	2,533	4.86	12,312.05	948	2,400,850
		Total		4,428	28.05	124,216.93	5,470	24,222,301
2	II III IV V	Spruce	Spruce Land and Swamp.	11,613	17.97	208,632.93	3,504	40,683,421
		Balsam			3.38	39,276.25	659	7,658,869
		Pine	Pine Land	9,461	1.66	15,685.41	324	3,058,655
		Total		11,613	22.70	263,594.59	4,426	51,400,945
3	VI	Spruce	Spruce Land and Swamp.	855	24.23	20,718.79	4,725	4,040,164
		Balsam			1.96	1,672.81	382	326,198
		Pine	Pine Land	855	.07	60.30	14	11,759
		Total		855	26.26	22,451.90	5,121	4,378,121
		Grand total		16,896	24.28	410,263.42	4,735	80,001,367

CEDAR.

The stand of merchantable Cedar on Township 40 is so scattered that no limit for cutting has been fixed. There is no generally accepted stumpage rate for Cedar in this locality, and advantageous market conditions would depend largely upon whether some of the improvements advised later in this working plan were made. In some places all the live merchantable trees should be cut. It is recommended that the sale of Cedar be left to the discretion of the forest officials.

Under "Recommendations for a Mill and Branch Railroad" (p. 44), suggestions will be found regarding the utilization and sale of the dead Cedar on the township.

DEAD SPRUCE.

In order to show how the mature trees are going to waste on Township 40, the dead Spruce were calipered and recorded on the valuation surveys. No stubs nor broken-top trees were included, and only those 10 inches and over in diameter breasthigh were measured. The result is shown in the following table

Table No. 26.—*Dead Spruce on Township 40.*

[Average of trees 10 inches and over in diameter breasthigh.]

Type.	Number of valuation surveys.	Average number of trees per acre.	Average diameter breasthigh.	Maximum diameter breasthigh.
	Acres.		*Inches.*	*Inches.*
Spruce Land	953	1.623	18.6	30
Swamp	90	.900	16.9	27
Total merchantable area	1,043	1.561	18.5	30
Upper Spruce Slope	37	2.000	17.1	29

It will be seen that the dead Spruce are for the most part large trees. The contents of a tree 18 inches in diameter breasthigh is 1.79 standards, or 349 feet B. M. On the whole merchantable area of 16,896 acres there would be 26,375 dead Spruce, with an average contents of 1.79 standards. The total dead Spruce gone to waste is thus 47,211.25 standards, which, with a stumpage value of 50 cents per standard, means a loss of $23,605.62. That such waste should be prevented hereafter is clear. If cut at once, many of the trees listed as dead Spruce could be still utilized for lumber and some of them would make good saw logs.

REMAINING SPECIES.

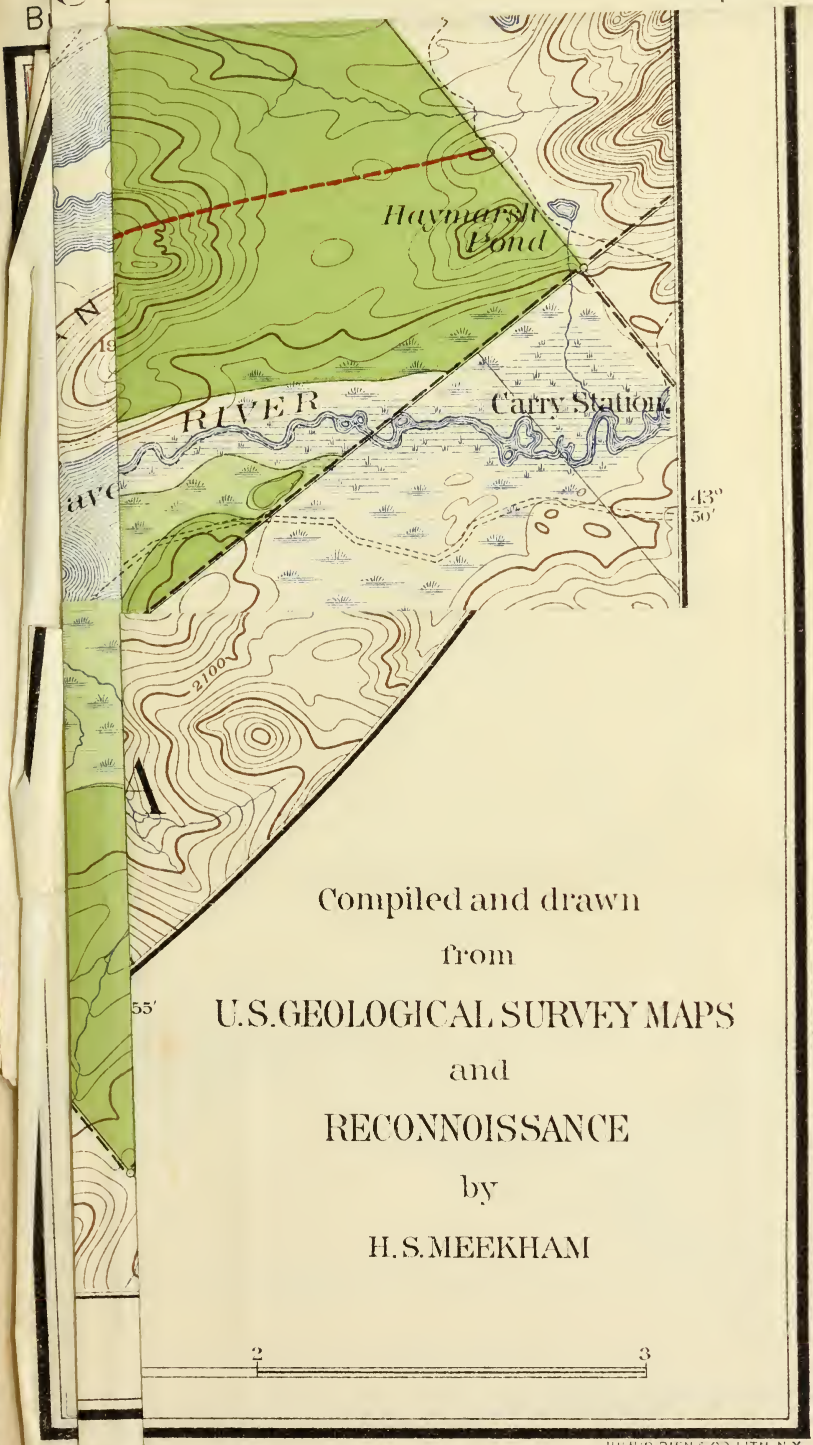
There are strong reasons why the remaining species should not be lumbered now. There is a good stand of young Hemlock on the tract, but as it is yet far from mature better returns will be obtained by allowing the trees to grow than could be got from their present sale. Besides this, Hemlock bark is not sufficiently thick on small trees to make it valuable, nor heavy enough to sell to advantage by weight. That the bark should be used when this species is logged is obvious, both because of its value and because in order to drive the logs the bark must be removed. In addition, the value of Hemlock is at present comparatively small. A rise in value may reasonably be expected in the future, since Hemlock is being used more and more in the place of Spruce as the demand for the latter increases.

HARDWOODS.

There are several reasons which make present lumbering of the hardwoods inadvisable. It is recognized that for the benefit of the young growth it would be best to remove the large hardwoods at once and so improve the conditions for reproduction of the more valuable softwoods. But present rates render the logging of hardwoods on Township 40 impracticable. Prices do not warrant generally the cost of building logging roads nor the hauling of logs to the present railroad, which would be necessary, since it is not feasible to drive hardwoods.

However, with the construction of a manufacturing plant on Township 40 and the necessary branch railroad connecting with the Raquette Lake Railway, the more valuable species, as Birch, Hard Maple, Beech, Black Cherry, and White Ash, of the larger diameters, would undoubtedly find a ready sale at good prices. The roads that had been cut for the Spruce and Pine could be utilized for removing the hardwoods. The cost of lumbering would be reduced and, consequently, the stumpage would become more valuable, while the tops might be sold for fuel or for the manufacture of charcoal, wood alcohol, etc. This should be done in order to get them out of the way and so lessen the danger from fire.

Map III



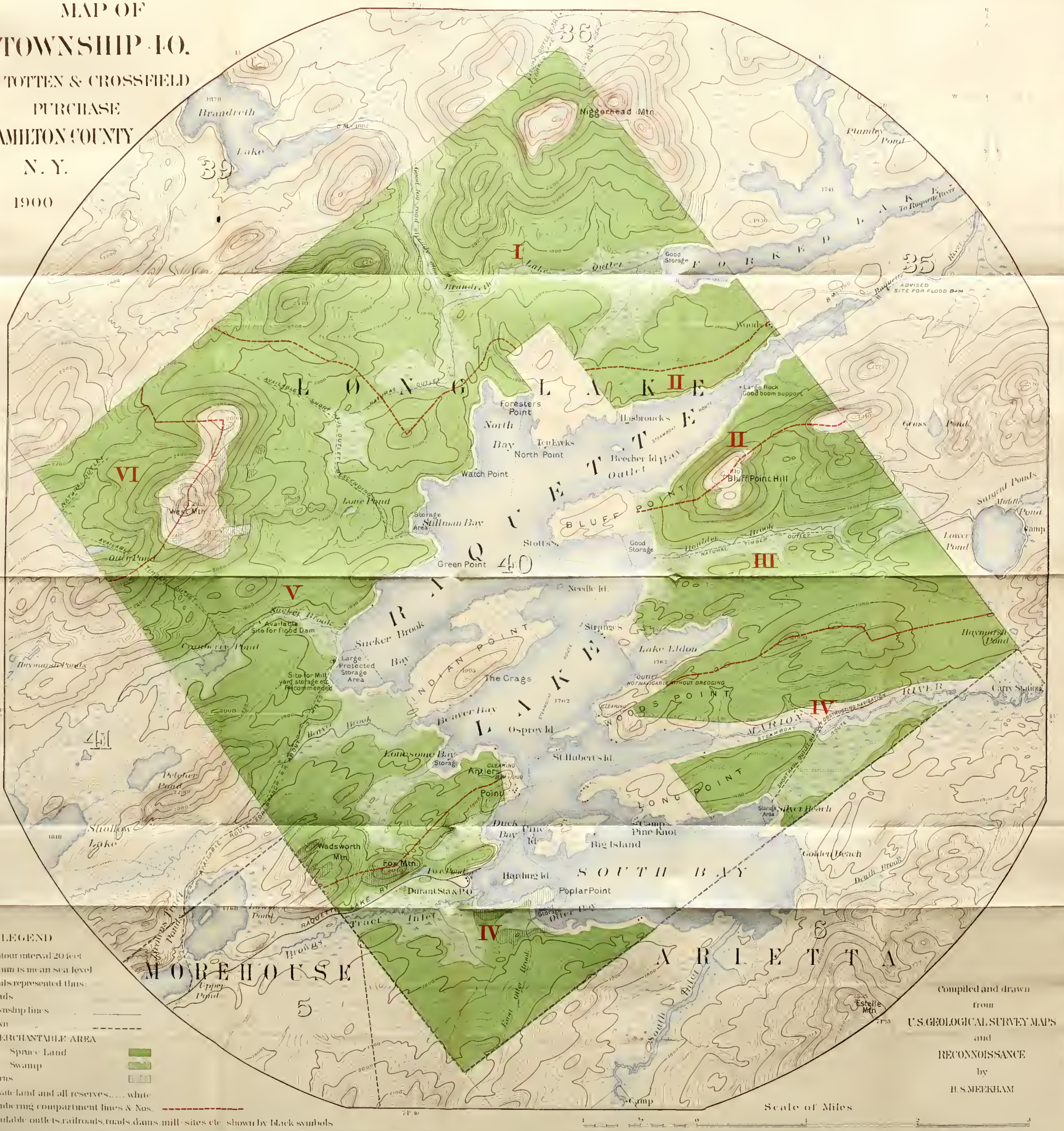
Compiled and drawn
from
U.S. GEOLOGICAL SURVEY MAPS
and
RECONNOISSANCE
by
H. S. MEEKHAM

JULIUS BIEN & CO LITH. N.Y.

LUMBERING MAP

MAP OF TOWNSHIP 40.

TOTTEN & CROSSFIELD PURCHASE
HAMILTON COUNTY
N. Y.
1900



LEGEND

Contour interval 20 feet
Datum is mean sea level
Trails represented thus:
Roads
Township lines
Town
MERCHANTABLE AREA
Spruce Land 🟩
Swamp ▨
Burns ▥
Private land and all reserves...... white
Lumbering compartment lines & Nos.
Available outlets, railroads, roads, dams, mill-sites etc. shown by black symbols

Compiled and drawn
from
U.S. GEOLOGICAL SURVEY MAPS
and
RECONNOISSANCE
by
H. S. MEEKHAM

The larger portion of the hardwood timber on Township 40, tributary to Raquette Lake, is on Compartments Nos. II, III, and V, and could be brought to the hereafter proposed location for a mill much more cheaply than to the present railroad station on the lake.

For these reasons it would be more profitable to lumber the softwoods first and the hardwoods afterwards, although the opposite arrangement would be better for the forest.

NATURAL ADVANTAGES OF TOWNSHIP 40 FOR LUMBERING.

Township 40 is a particularly desirable tract upon which to begin conservative lumbering by the State. Its timber is mature, and under proper restrictions may be removed with entire safety to the forest, transportation will be cheap and easy, large markets are easily accessible, and the work and its results will be fully open to public inspection. The streams tributary to Raquette Lake, which, as will be seen by a glance at the map, come in from all sides and run in most cases completely across the township, make easy and natural outlets for all the timber to the lake, with the exception hereafter noted. Raquette Lake has two outlets, the Raquette River to the north, which leads to the markets and mills below, and the Raquette Lake Railway, which connects with the New York Central Railroad at Clearwater Junction. The timber on the northeast quarter is tributary to Forked Lake or Brandreth Lake Outlet. The latter runs from the north line of the township southeasterly into Forked Lake, and is fed by several small streams on each side. These afford a natural outlet for all the timber on that portion of the tract designated as Compartment No. I, by way of Forked Lake into the Raquette River, and down the latter, which leads to the markets of Tupper Lake and Piercefield, where are some of the largest lumbering plants, sawmills, pulp mills, and manufactories in the Adirondacks.

The larger part of the timber upon Townships 6, 5, and 41, which is owned almost entirely by the State, is also tributary to Raquette Lake. If these townships were to be lumbered together with Township 40, it would pay to make permanent improvements, such as roads and dams, in addition to those advised in this working plan. These additional improvements would be hardly justified, however, on Township 40 alone, on account of the comparatively small amount of timber remaining after the deduction of the summit reserves and the reserved strips along the lake front, together with the water acreage.

The topography of Township 40 is very favorable for lumbering. The small streams which reach across the township have, with few exceptions, a gradual descent to the lake, and empty into it in some sheltered bay where logs may lie safely boomed after the ice breaks up in the spring, protected by the trees about the shores from being driven about and scattered by heavy storms. Here they could rest safely until it should be deemed advisable to tow them by steamer or otherwise to some point where they could be loaded upon cars, or to the Outlet, down which they could be driven to the markets below, or to some point on the lake where there might be a mill erected to manufacture the lumber. The railroad, which has been completed from Clearwater to Raquette Lake, and the steamboat lines on the lake could well be used to bring in the necessary men, supplies, tools, and outfit for removing the timber. At present there are several steamboats which could be hired with their crews at very reasonable figures. These boats would make it entirely unnecessary for the lumberman to incur the expense of building steamboats to do this portion of the work, or of hauling supplies over a long supply road with teams. Supplies could be moved quickly and cheaply to any desired point on the lake, whence it would not be a long distance by road to any place where a lumber camp would naturally be located. Long-distance telephone and telegraph lines traverse the township, making possible quick communication with a base of supplies—a condition which is found in hardly any other locality which could be selected in the New York State Forest Preserve.

It is plain from these facts that unusual natural advantages, together with the excellent facilities for transportation, make this tract an especially favorable one for profitable lumbering.

DIVISION OF TOWNSHIP INTO COMPARTMENTS.

It was, as has been explained, considered advisable, for the purpose of estimating the stand of timber, to divide the township into six compartments. Map III shows the boundaries of these compartments by broken lines.

Compartment No. I contains all the northeast quarter of the township naturally tributary to Forked Lake or Brandreth Lake Outlet, except that portion which, although naturally tributary to Brandreth Lake Outlet, has been included in Compartment No. V. This exception has been made because the log haul would be materially shortened by leaving the brook at the point indicated as "available short haul" on Map III and going south across the marsh to strike the small brook running into Stillman Bay, on Raquette Lake. The cost of hauling logs for that portion of the tract would in this way be greatly diminished. Compartment No. I is an important one, for the reason that its timber can not be lumbered into Raquette Lake cheaply, but must go to Forked Lake, and thence north by way of the Raquette River.

Compartments Nos. II, III, IV, and V are simply the subdivisions of the Raquette Lake tract into the several subordinate watersheds, separating those portions of the township naturally tributary to the various inlets of the lake.

No. II includes that portion tributary to Outlet Bay on each side of the lake. No. III comprises the area tributary to Boulder Brook.

No. IV contains the section naturally tributary to Marion River and South Bay in the southeast quarter, and also that in the southwest quarter tributary to Otter Bay and Browns Tract Inlet. No. V covers that part of the township which is naturally tributary to Beaver Bay, Lonesome Bay, and Sucker Brook Bay, by way of Cranberry Pond Outlet, and all the timber lying on the east side of West Mountain and tributary to Stillman Bay by way of Lone Pond Stream, and as far east as the Ten Eyck private holding. No. VI is a small compartment which lies back of West Mountain and includes Otter Pond. The timber upon it is not naturally tributary to either Raquette Lake or Forked Lake, but could be brought across into Cranberry Pond Outlet.

In dividing the township into tracts for lumbering, the six compartments into which it was divided, for the purpose of estimating the stand of timber, fall naturally into three blocks. One includes that portion tributary to the Brandreth Lake Outlet and Forked Lake (Compartment No. I); another, that portion tributary to Raquette Lake (Compartments Nos. II, III, IV, V), and which should be lumbered to that point; and the third (Compartment VI), the small compartment back of West Mountain, from which the timber would naturally go to Moose River. The latter should be lumbered with the timber on Township 41 in the same valley and watershed, but could be brought to Raquette Lake via Otter Pond. (See available route shown on Map III.) If this route were used it would be necessary to employ tow teams to help in hauling the logs from Otter Pond to the top of the divide between this compartment and No. V; or, since the ascent is short, although comparatively steep, the work could be satisfactorily done by the aid of a small hoisting engine and wire cable at the top of the divide.

NATURAL OUTLETS FOR TIMBER.

There are only two outlets advisable for any of the timber on Township 40, and but one for that portion of the northeast quarter which is included in Compartment No. I. As already explained, all the timber on this compartment must of necessity go out by way of Forked Lake and the Raquette River (outlet of Forked Lake), through Long Lake and the Raquette River again, and so down to some of the many manufacturing points below. But, although there is only one outlet for Compartment No. I, there would be no trouble in disposing of the stumpage on this compartment for its full value, as there are a number of responsible lumbermen and manufacturers who have already signified their intention to bid for the timber if it is offered for sale.

There is a small amount of timber on the northern slopes of Pilgrim and Nigger Head mountains, near the north corner of the township, which could be brought to Brandreth Lake Outlet, but which could be hauled more cheaply direct to Forked Lake by way of High Pond. (See Map III.)

All the rest of the timber on the tract, except that upon Compartment No. VI, could be brought to the lake on a down-grade road by following the watercourses of some of the inlets and their small feeders, and would have two available outlets to market, one by the natural water outlet of Raquette Lake into Forked Lake, from there into the Raquette River, and so down to the manufacturing plants which are located at various points along the stream below, from Tupper Lake to Potsdam and Norwood; the other by way of the Raquette Lake Railway, which, as will be seen from the map, touches the lake at a point near the entrance of Browns Tract Inlet.

This affords a means of transportation for either logs or lumber direct from the lake to any desired point. This fact should have marked effect upon the bidding for the stumpage on this tract. It will readily be seen that the manufacturer who has a plant located at some distant point not on the Raquette River could get the timber to his mill more cheaply and quickly by loading it upon cars at Raquette Lake and shipping it direct to his mill than by driving it downstream to the nearest point where a railroad could be reached (which is at present Tupper Lake village), as he would otherwise be compelled to do. When there, after paying the cost of driving and of sorting the logs from the other timber in the stream, he would still have the additional cost of loading and of transport to his mill—an added expense which would not allow him to compete successfully with the manufacturer whose mill is on the natural outlet. But the railroad, coming directly to the lumbering center of the tract, makes it possible to load and ship the timber right from the lake without the expense of driving the logs, and the purchaser from a distance would therefore be able to offset the cost of loading and transport against the cost of driving. Hence he could afford to pay as much for the stumpage as the man on the stream below, provided he could secure satisfactory freight rates.

LUMBERING—GENERAL.

There are two ways in which Township 40 might be lumbered; the one by the State itself, the other through the sale of stumpage by the State.

LUMBERING BY THE STATE.

Lumbering by the State would necessarily entail the purchase of a large lumbering outfit, such as horses, sleds, wagons, blankets, dishes, etc., the hiring of clerks, foremen, and cooks, and all the detail work incident to the practical execution of a lumber job. State or governmental organizations are badly suited to work of this kind. It is altogether unlikely that the State would be the gainer financially by carrying on the lumbering. The private lumberman, with his knowledge of all the methods of securing necessary help and supplies, and with his lumbering outfit already on hand, can undoubtedly lumber more cheaply, and would be willing to pay at least as much for the stumpage as the State could hope to realize by doing its own lumbering. The task would be still more complicated if the State should erect a mill and manufacture and market the lumber. For these reasons lumbering by the State is not advisable.

THE SALE OF STUMPAGE BY THE STATE.

The fact that the end of the supply of Spruce timber throughout the State is plainly in view furnishes a potent reason why the stumpage may be sold for its full value.

The stumpage upon each compartment separately or upon the whole tract could be put up for sale to the highest bidder, to be removed under certain rules and restrictions, about which more will be said further on. The method of sale would, of course, be regulated by the State officials in charge of this work, but it should be by sealed bids, the timber to go to the highest bidder, since it is probable that by this method the State would receive a higher price for the stumpage than if it were sold at private sale.

Lumbering by the sale of stumpage, with the understanding that the timber should be removed, would be particularly advisable for Compartment No. I in the northeast quarter of the township, as there is hardly enough timber in that part of the tract to warrant the erection of a mill. Logs have already been driven from the east line of Township 40 to Tupper Lake and Piercefield, and that would be the best way to dispose of the timber on this compartment.

The timber on the remainder of the tract should be sold to one purchaser. It would thus undoubtedly bring a higher price and attract a more reliable class of bidders than if it were sold in small lots. Such sale would also avoid the necessity of having a large number of contracts with small contractors, and would lessen the burden of supervision which necessarily goes with operations of this kind with irresponsible "wildcat" jobbers. The timber would also probably be cut in a much more satisfactory manner and with less friction between the lumberman and the inspector. The purchaser of the stumpage would, of course, have the option of reselling it to the small contractors, but he himself would be bound by the contract and held responsible for the careful cutting of the timber according to the rules and methods prescribed. It follows, therefore, that the best way to lumber Township 40 is by the sale of stumpage to the highest bidder. Under this plan the purchaser should have the right to build a mill at a point on the lake which could be easily connected by a railroad spur with the Raquette Lake Railway, for reasons stated fully under "Recommendations for a Mill and Branch Railroad." (See p. 44.) He should also have the right to improve the stream and to build a dam at the foot of Raquette Lake—a matter which is discussed fully under "Recommendations for a Dam at the Foot of Raquette Lake." (See p. 47.) As shown later, neither dam nor mill will destroy the use or beauty of the lake as a resort.

There are a number of possibilities in the lumbering of Township 40, which are shown on Map III. A careful study of this map is advised for those interested in the working plan.

RECOMMENDATIONS FOR A MILL AND BRANCH RAILROAD.

A strong argument in favor of allowing a mill to be built on the shore of Raquette Lake is that any reputable firm, after having gone to the necessary expense entailed thereby, would be particularly careful to see that the rules for cutting were observed, lest by violating the contract they should forfeit the right to cut the timber, and thus lose the money they had invested in the mill. A second advantage derived by the State would be that, since logs could be taken from the water directly into the mill, avoiding the expense of driving them a long distance or loading them on cars to be taken to the place of manufacture, the lumberman could afford to pay a higher price for the stumpage, provided it were possible to obtain a sufficient quantity of timber to warrant the erection of a mill and the building of a spur track to connect it with the main line of the railroad.

If logs or lumber were to go out by rail, there are the following reasons why it would be advisable to allow the construction of a spur railroad track to Sucker Brook Bay. (See available railroad route and mill location on Map III; also shown in Pl. V, figs. 1 and 2.)

There is a large storage area at this point where timber could be held until it was desired to remove it, without interfering with either navigation or summer travel, of which there is comparatively little on this part of the lake. All logs and timber should be in this large storage boom or down the stream in the spring before the summer travel on the lakes commences. A mill located here would be far enough away from the common routes not to annoy summer tourists, who might mistakenly be opposed to conservative lumbering, and would still be within easy reach of those who were interested in seeing how the work was being carried on.

The highway running from Browns Tract Ponds to this point on Raquette Lake has been practically abandoned as a wagon road, and for a considerable distance could be utilized for the track bed of the railroad without much cutting. The timber that stood on the right of way along this proposed route has already been cut for a portion of the distance, as it was at first intended to bring the main railroad track to the lake at this point. This was not done because the present route shortens the steamboat run to Marion River, making a quicker connection with the Blue Mountain Lake region. To

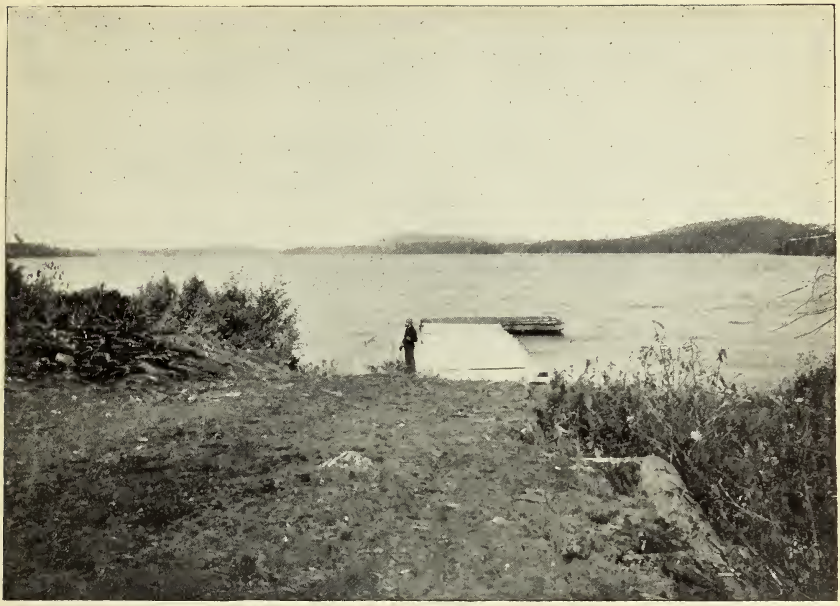


FIG. 1.—SUCKER BROOK BAY, FROM PROPOSED TERMINUS OF BRANCH RAILROAD AND ADVISED LOCATION OF MILL.

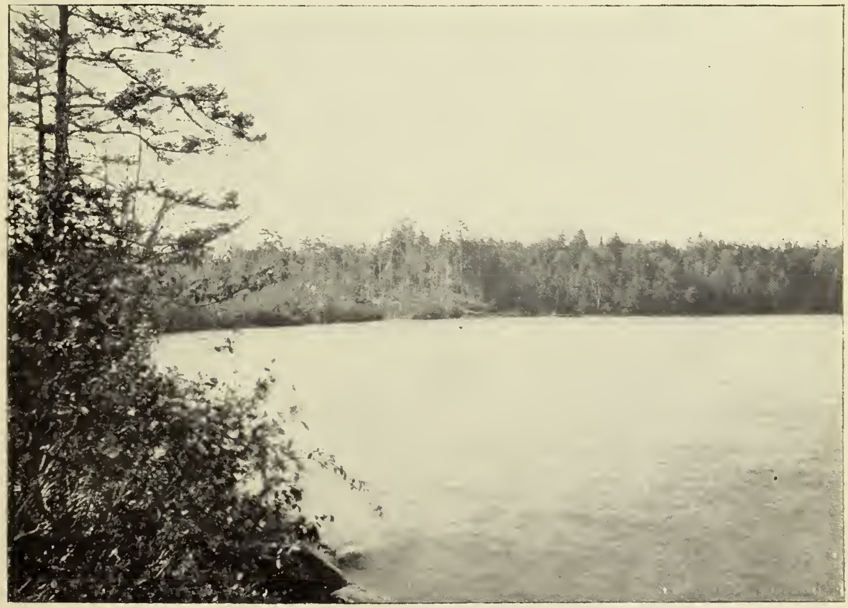


FIG. 2.—TERMINUS OF SUCKER BROOK HIGHWAY ON RAQUETTE LAKE.

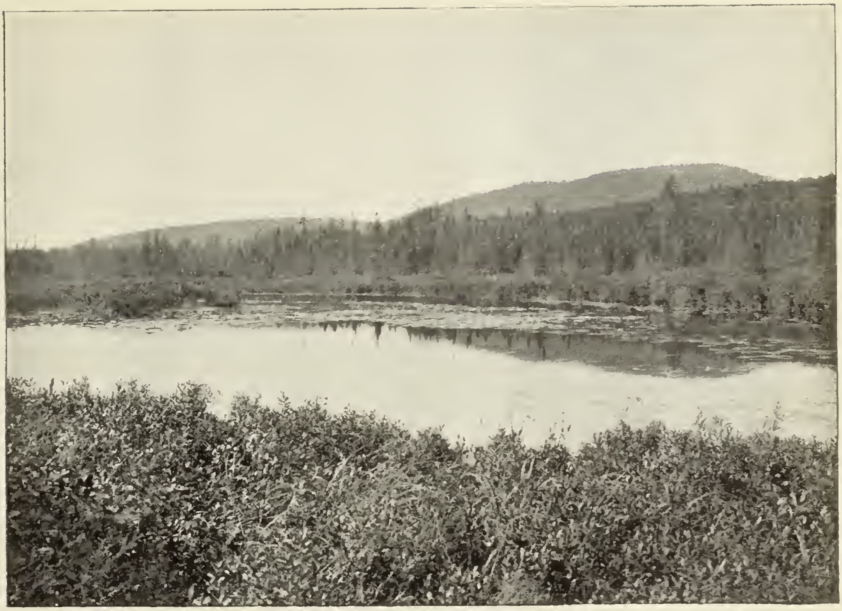


FIG. 1.—YOUNG LIVE TAMARACK ON BRANDRETH LAKE OUTLET, NEAR FORKED LAKE.

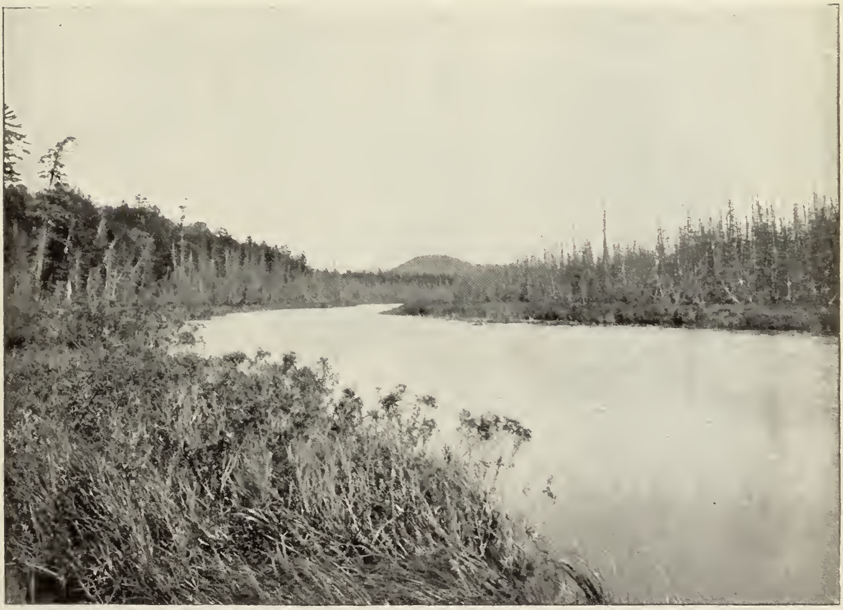


FIG. 2.—DEAD CEDAR ON MARION RIVER; KILLED BY FLOODING.

no other suitable bay on the lake could a spur be constructed with so little damage to the forest as to this. A large boomed storage area here would not be exposed to the usual danger of having booms cut or opened by guides and tourists traveling by water, as there is no connecting water route into this bay. This would not be the case if it were attempted to store logs near the present railroad station, as that location is on a long-used water thoroughfare between Raquette Lake and the Fulton Chain, up Browns Tract Inlet. Again, the coming of all passenger steamers and launches on the lake to the present railroad station and steamboat wharf several times a day, coupled with the fact that there is not room enough in the bay to accommodate both branches of business satisfactorily, is an additional reason why that location would be undesirable. Sucker Brook Bay is much nearer to the middle of the lake and of the township than the present station, and if it were selected as the terminus of a spur track long towing by steamboat from a large portion of the tract would be avoided.

There are many reasons why it would be advisable to allow the erection of a mill at the point shown if a satisfactory bidder could be secured to undertake it. It would open a means of manufacturing into shingles much of the refuse Pine and Cedar which it would hardly pay to ship or drive to other markets in the log. If this Pine and Cedar could be manufactured near the lake, the slight expenditure necessary to bring it to the mill would be warranted. There would be a great many Pine butts and tops and broken pieces of Pine which could be made into shingles. There are also at present on the tract many Pine trees that have been cut or blown down and shaved shingles manufactured from a small portion of the butt. The remainder of these trees has been left in the woods and could in most cases be sawed into excellent shingles. It should be utilized in this manner and sold at a reduced stumpage rate, if only for the purpose of removing the trees, which now not only increase the danger from fire, but entirely prevent reproduction on the space they occupy and are almost indestructible by decay.

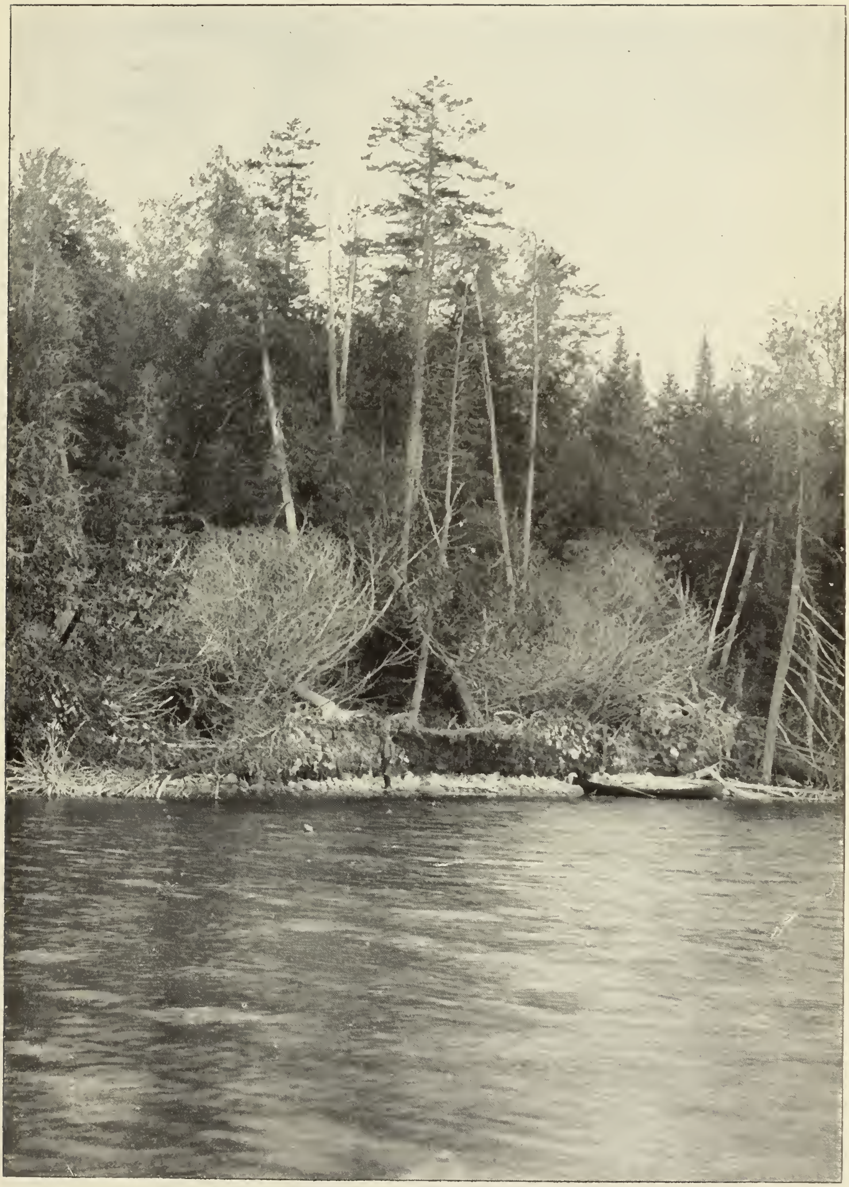
Around the shores of the various inlets of the lake—more especially along Marion River and Browns Tract Inlet—there is a large amount of dead Cedar which has been killed by the water having been held at too high a point in the summer. The effect of this is shown in Pl. VI, fig. 2. This Cedar could be utilized for shingles, fence posts, rails, and telegraph poles. It might be sold at a reduced rate in the same way as the refuse Pine. It is not likely that it would bring a very large price, but it should be sold with the provision that the trees be cut very close to the ground and that all the tops and branches be burned during the winter, or when there is no danger from fire. There is a considerable amount of Cedar on the tract which could be sold, and there would probably be a market opened for it if the erection of a mill were allowed.

If the right to construct a mill and a spur from the main railroad line were granted, those who did not own a mill but who were desirous of purchasing the stumpage could continue their lumbering, even if the millmen and manufacturers attempted to form a combine to keep prices down. They could hold the timber in a large storage boom at this point until they had received a fair offer for it, since it could be shipped at any season of the year when the lake was free from ice; or, with the concession advised, if there were no possibility of their selling it in the unmanufactured state, they would have the opportunity to erect a small mill and to manufacture their logs into lumber. The advantage of having these different ways of disposing of the timber can hardly be appreciated by those without actual experience in lumbering and without knowledge of the difficulties which are oftentimes encountered from unexpected sources. These concessions would undoubtedly have a marked effect on the stumpage prices offered. There would be no danger to the owner of getting his logs hung up in a log drive as a result of low water, drought, or other causes, and of being compelled to lose materially by his failure to deliver the timber at a certain time, since the water is of sufficient depth at this point to permit of logs being floated to a mill slide or steam jack works without being raised above its natural level. The shore at the place shown on the map as a proposed mill site is of a firm, sandy soil. It would admit of easy grading, and could be quickly and cheaply brought into proper condition for erecting a mill, for the necessary side tracks for holding cars, and for piling ground for lumber.

It will be seen by a glance at Map III that there is a large amount of timber on Township 40 which would come naturally to this bay. This would include all the timber from the Cranberry Pond district and the south side of West Mountain, as well as all from Compartment No. VI and the Otter Pond country.

That portion of the timber tributary to Beaver Brook could also be hauled directly into this storage boom without towing by steamboat, as there is a swamp running from the south end of Sucker Brook Bay through to where Beaver Brook comes into the lake (see Map III), and there is no grade between these two points. In case it should eventually be decided to allow the timber on Township 41 to be cut, there is a heavy stand throughout that area tributary to Cranberry Pond, Shallow Lake, Pelcher Pond, and Queer Lake, all of which could be driven down directly into the storage boom if some improvements in the stream were made. All timber coming into Boulder Brook Bay, Stillman Bay, and Outlet Bay could be quickly and easily towed across the lake when the wind was favorable, and the only timber that would require any long towing by steamboat would be the comparatively small amount in Compartment No. IV.

The construction of the spur track would be necessary if it were



TREES ON OUTLET BAY THROWN BY ICE.

decided to sell the hardwood stumpage and allow the timber to be manufactured in a mill erected on the township, or to ship the logs out, as this is a central point. The map shows that back of each of the points or peninsulas, except Woods Point, there is a depression or swamp running through from one bay to another, which is low enough not to interfere with the hauling of logs across the peninsula, thus obviating the necessity of going around the points. This condition rarely exists, and forms one of the natural advantages of the township for lumbering purposes. This would not be of so much importance in softwood lumbering, but would be a great advantage in the case of hardwoods, since they will not float a long distance, and must be hauled by team to a place where they can be loaded upon cars or be manufactured. The fact that they could be hauled directly across these points from one bay to another would shorten the haul very materially, and consequently save a large amount of money. The possibility of having roads cross these points through swamps, which would protect them from the drifting snows invariably found on a lake road, is also a decided advantage.

If it should eventually be decided to sell the Hemlock bark and logs, this would be the most convenient center from which to ship the bark to market in cars. The bay is protected by small, well-timbered ridges, which would serve as breaks against the prevailing wind. The effect of wind on the shores in the spring is shown by a view taken near the Outlet. The trees were overturned by an ice pack, which was driven in large masses into this bay by the strong south and west winds. These usually prevail during the early spring, when the ice is breaking up, and through the early summer, at a time when log driving is generally being carried on. The result shown in Pl. VII was noticed only in places where the south and west wind strikes the shore. The only objection, from a lumberman's standpoint, to the location of a mill at Sucker Brook Bay, is that the prevailing wind is from the south and west and would tend to hold the logs offshore. But this objection is more than counterbalanced by the many other points in favor of this place, and the timber can be held inshore without large expense by the use of lever winches and kedges. The prevailing wind is an important consideration in choosing the location of a mill on any lake. On this lake, however, there is no choice except to take the most suitable bay on the side nearest the railroad, and the one recommended seems to be the best possible from all points of view.

RECOMMENDATIONS FOR A DAM AT THE FOOT OF RAQUETTE LAKE.

A permanent dam should be constructed at the foot of Raquette Lake, with suitable sluices for logs and properly constructed wastegates for keeping the water at a uniform height on the lake during the summer season, and also for driving logs from this lake into

Forked Lake in the spring, if desired. The dam should be built at a point about 500 feet below the present combined dam and bridge, at or near the point shown on Map III. The existing dam should be removed entirely, and the highway which at present crosses on top of it should be made to cross over the proposed dam. If it is to be built of wood, the work should be done at once, before the Pine timber on Township 35 is removed, since this is the most accessible for the purpose, and there is a heavy stand near the proposed location which could probably be secured now at a reasonable price. As the timber rights were reserved when the south half of Township 35 was sold to the State, it is quite probable that this timber will be removed within two or three years.

The control of the water in Raquette Lake should be placed entirely in the hands of a State official, since unless this is done there are many interests which will conflict. Such a conflict would be lessened by the building of a properly constructed dam and the regulation of the flow of the water with impartiality and discretion. There have already been many thousand dollars appropriated by the State at various times for the purpose of improving the Raquette River from Potsdam to its source in Hamilton County (see Report of the New York State Forest Commission, 1893, Volume II), but so far as has been learned none of the money has ever been expended upon the stream above Long Lake.

The stream between Long Lake and Forked Lake has been improved by private lumbermen, so that it is now possible to drive logs north from Forked Lake. There are still some rapids between Forked and Raquette lakes in which are many large boulders which would have to be removed, and there should also be some side piers built in the stream at different places, more especially one at the island midway between the two lakes, for the purpose of confining the stream to one channel. There is also a large amount of driftwood jammed at different points on the rapids, the accumulation of spring freshets for years, that would have to be removed before it would be possible to drive any of the timber belonging to the State above this point down to the natural water markets below. With a dam properly constructed the water could be held overnight or until a certain height was reached. Then, when the water was released, the logs and timber could be sluiced through very rapidly until the water in the lake was lowered to a certain point, when the dam should be closed. When the water in the lake had again reached the specified height the sluicing could be repeated until the timber that was to be delivered downstream was run through, after which the water could be maintained at a steady level on the lake above during the summer months, using the same dam for both purposes. Thus the use of the proposed dam would not raise the water in the lake any higher than the present dam. The logs would be driven by temporarily lowering the water.

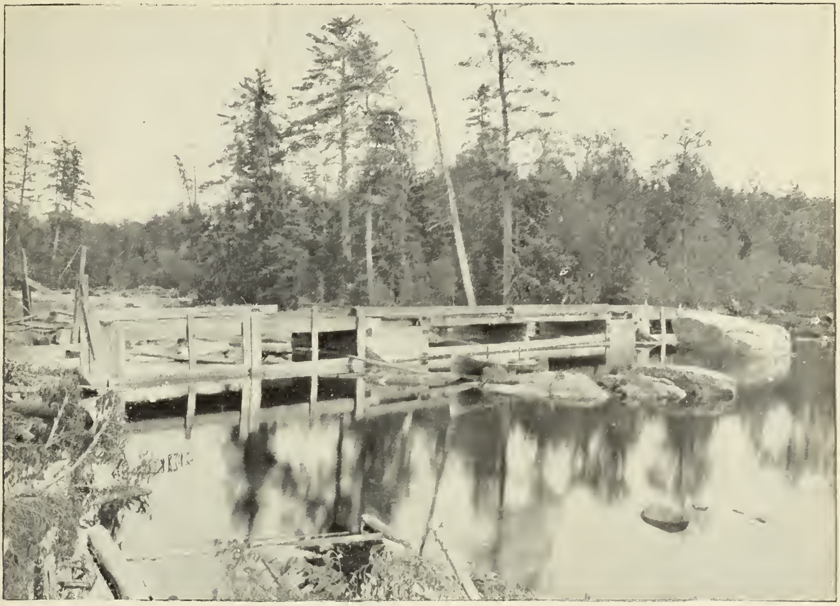


FIG. 1.—PRESENT BRIDGE AND DAM, FROM RAQUETTE LAKE.

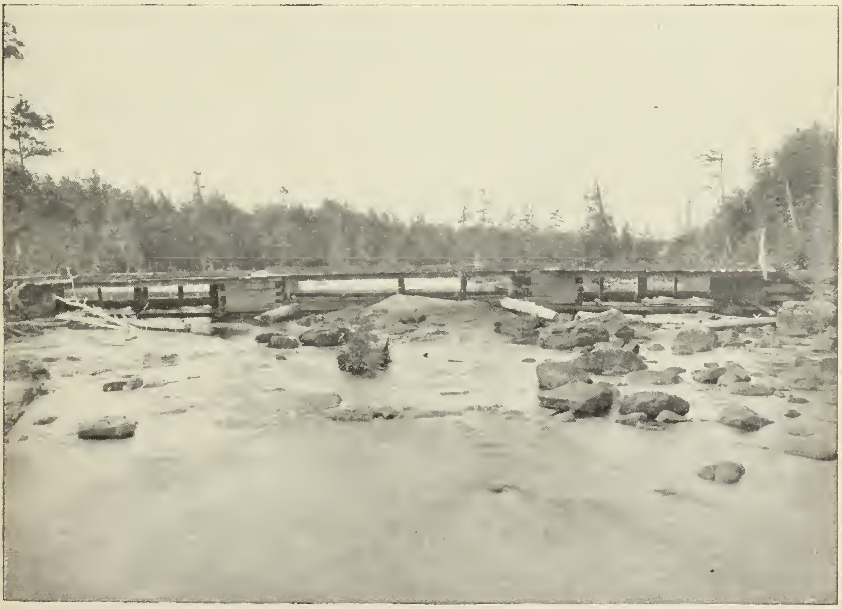


FIG. 2.—PRESENT BRIDGE AND DAM, LOOKING UPSTREAM.

The occasional lowering of the water necessary to drive the logs should be over early in the spring, before tourist travel had begun, and the lake could remain at its normal level throughout the summer. These requirements can not be satisfactorily fulfilled by the present dam, which evidently was intended only to maintain the water at a suitable height to facilitate steamboat navigation on Raquette Lake, Marion River, and South Inlet. The level of the water in Raquette Lake is at present controlled entirely by the steamboat company.

Steamboat navigation on the lake above would not be interfered with by the adoption of the proposed method of regulating the use of water for log driving. It would not be necessary to raise the water above the high-water mark on Raquette Lake, nor to cause any serious damage to property on the shore. It would be necessary, however, to build a suitable dam at the point shown and to remove the present combined bridge and dam, as it is built at a point where the stream is wide and shallow and will not allow the release of sufficient water to properly flush the stream for driving below, unless the planks which are set up against the upper side of the bridge for the purpose of closing the dam are removed for a considerable distance from along the present bridge front. When the water is at ordinary height, there is not sufficient depth to carry timber through the present dam. And when the high water of the spring freshets swells the stream to a proper driving depth the logs would strike the bridge roadway stringers, for the bottom of the bridge stringers is only 4½ feet above the top of the sluice, and unless the water is just at a certain height, logs can not go through. The stringers could, of course, be raised in the spring for the purpose of sluicing logs, if there were no other objections to the present dam; but this is only one of the minor reasons why it would not satisfactorily serve the double purpose of driving logs or timber out of the lake in the spring and maintaining the water at a steady level in summer. At the time the photographs shown in Pl. VIII, figs. 1 and 2, were taken, there were only 10 inches of water above the sluice floor.

The site recommended for the dam is shown in Pl. IX, figs. 1 and 2, and is the best location available. The bed of the stream is narrowed here, and there are good, high banks, especially on the south side. This is the nearest point to the lake at which a dam can be built entirely on State land, as the dividing line between the State land and private holdings in Township 35 runs across the combined dam and bridge now in use and clears this location by about 100 feet on the north side of the stream. A dam 12 feet high built here would have its top exactly level with the top of the present dam, and would raise the lake when full of water to just the same level. This level is shown by the white flag on the pole in Pl. IX, fig. 1. The location of the proposed dam, the original bridge piers, and in the distance the present bridge and dam, are clearly shown in Pl. IX, fig. 2.

There are several short sets of rapids between this point and Forked Lake similar to those already shown. The building of a dam here and the removal of the obstructions above—the old bridge piers and the present dam and large boulders—would allow the water to be discharged, through properly constructed sluices, with a sufficient head above it to give the required pressure to flush the stream below, and would furnish a sufficient depth in the sluices to carry timber through the dam when there was water enough in the stream to float it away. The removal of the present dam and other obstructions would allow the water to flow evenly and steadily over the wide and shallow portion of the Outlet where the present dam is located, and while furnishing a sufficient depth to float timber down to the dam, the added width of unobstructed flow would serve to keep the deeper and more narrow sluiceway below filled with water, according to the height and pressure of the water from the lake above.

The prevailing wind would be a decided advantage in driving logs from the lake downstream, as it would aid in moving them to the Outlet and holding them down to the sluicing booms. There is a large boulder which stands out of the water in Outlet Bay at the point shown on Map III, which would furnish an excellent boomstay for the purpose of holding the logs down the Outlet, if desired. Booms could be hung to this rock by drilling a hole in it and using a large iron split plug and wedge with a ring in the plug. The booms could be opened on one side, or both, as the case might require. These are some of the many natural advantages for lumbering this township. It is not considered necessary to mention all of them in detail. They will be readily apparent to the experienced lumberman.

The erection of a dam at the place proposed would raise the water above it, so that a large number of the rocks and boulders, which are seen below the present dam in Pl. X, fig. 1, would be covered by the back flow, and but few of them would need to be removed.

Unless this stream were improved and the right granted to drive timber from this lake to Forked Lake under certain restrictions, the lumbermen, manufacturers, and mill owners on the stream below would be practically barred from competitive bidding on the timber above this point, and such competition would be necessary in order to get the highest possible price for the timber.

According to the estimated stand of timber on Township 40, there are 410,263 standards of Spruce, Pine, and Balsam which it will be advisable to cut. If the Hemlock 14 inches and above at breastheight were included, there would be 544,526 standards on this township alone. An advance of 1 cent per standard on the stumpage price would realize to the State more than enough to cover the cost of making the proposed river improvements. The timber on this township alone would undoubtedly sell for at least 5 cents more per standard, or approximately 25 cents per 1,000 feet B. M., with a water outlet to market assured, than it would if confined to a single outlet, and that a

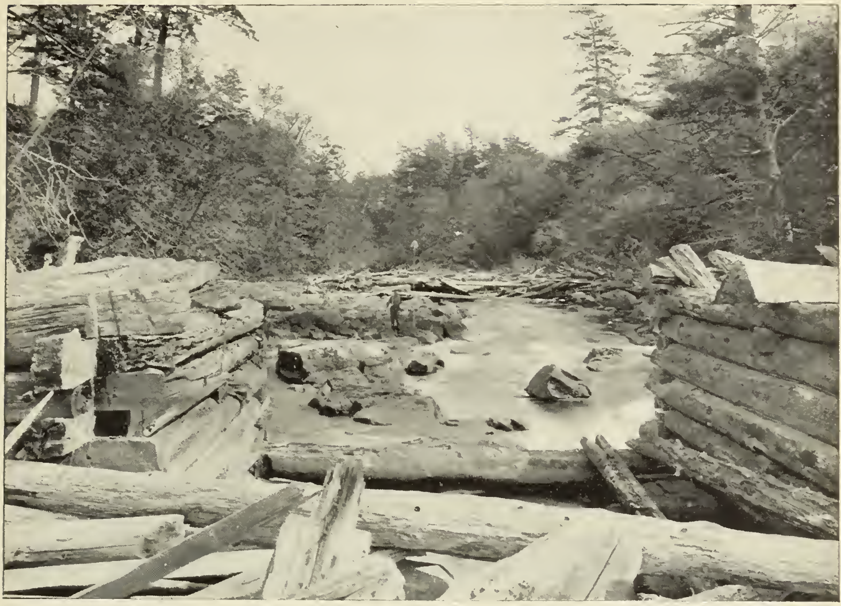


FIG. 1.—VIEW OF PROPOSED LOCATION FOR DAM, FROM ORIGINAL BRIDGE PIERS.

Elevation of top of present dam shown by white flag.

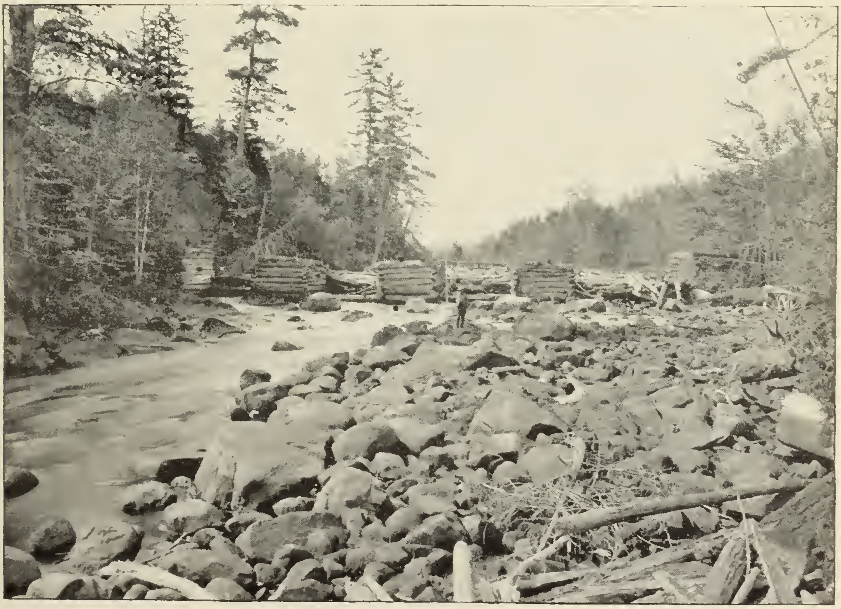


FIG. 2.—PROPOSED LOCATION FOR DAM, FROM BELOW.

Original bridge piers and present dam in the background.

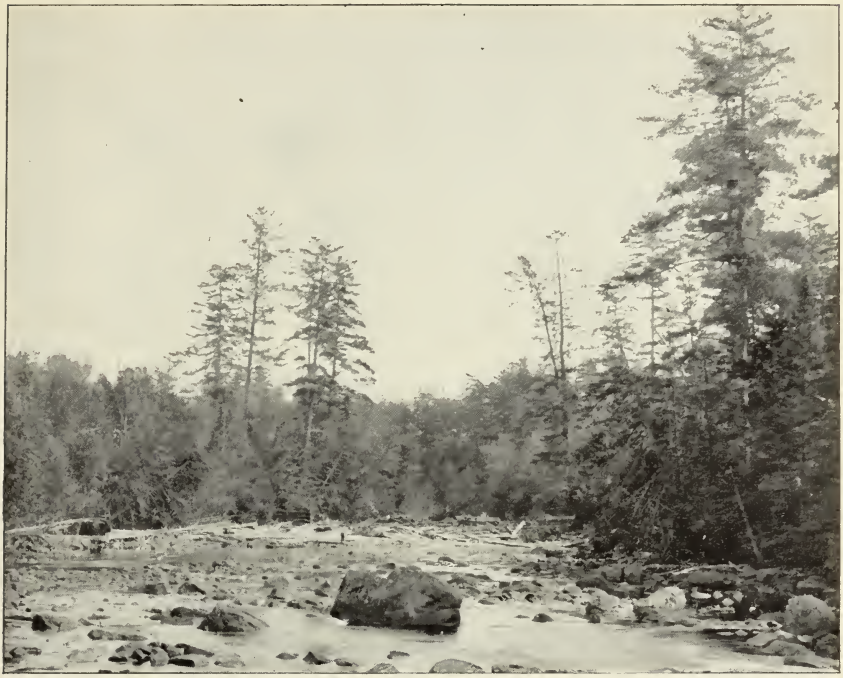


FIG. 1.—VIEW FROM PRESENT BRIDGE AND DAM, LOOKING DOWNSTREAM.

Piers of original bridge in the distance.

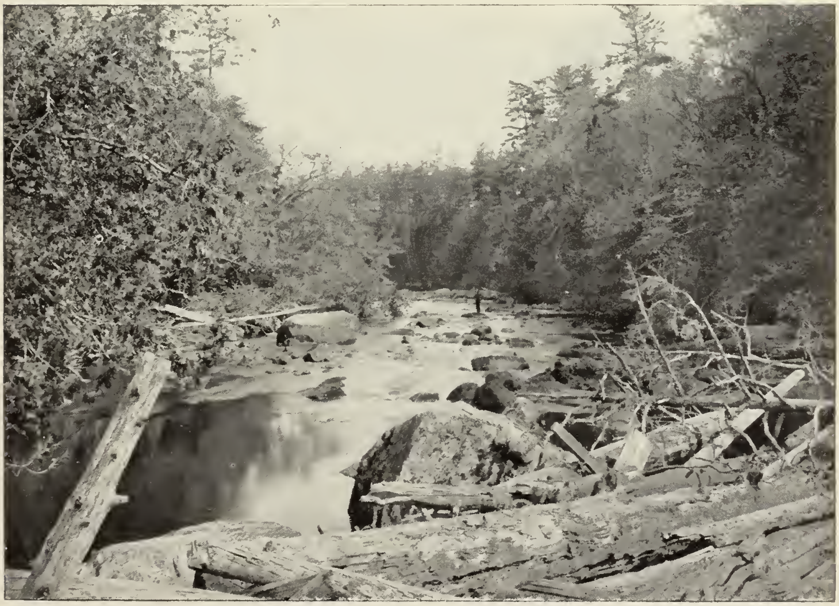


FIG. 2.—STREAM BELOW PROPOSED DAM SITE.

Short stillwater in the distance. Heavy stand of Pine on the right bank.

railroad. In the latter case, too, exorbitant and arbitrary transportation rates could be maintained if the railroad were inclined to do so, as it would have no fear of competition. The effect on the stumpage value of this timber of having two outlets would be very important.

On Townships 6, 5, and 41, after all private holdings have been deducted, there remain about 70,000 acres of land belonging to the State, from which the timber, in addition to that on Township 40, could come to this lake. If this land should yield the same average amount of Spruce, Pine, and Balsam per acre as estimated for Township 40, there would be 1,700,000 standards to add to the estimated 410,000 standards on Township 40. This would mean 2,110,000 standards of Spruce, Pine, and Balsam on the four townships. If the Hemlock were included on the same basis there would be about 2,800,000 standards of timber so located that they could be brought to this lake center, not including any of the Cedar.

Four thousand dollars would certainly cover the cost of all the necessary improvements, besides paying for all the timber and material needed for the construction of a wooden dam.

The small cost of the proposed improvements, when compared with the probable gain by the increased value of the stumpage, makes their construction imperative from a business standpoint. Each advance of 1 cent per standard on the stumpage on the four townships would mean a gain of about $28,000. There is no question but that the stumpage price would be very materially advanced by having two outlets and by the consequent rivalry in bidding.

STUMPAGE VALUES OF SPECIES TO BE REMOVED.

The prices of stumpage vary greatly according to the location of a tract, the topography, and the stand of timber. From the standpoint of the forester not less than of the lumberman, the prices that may reasonably be expected for the stumpage on Township 40 require consideration.

What the lumberman can afford to pay depends upon several conditions, all affecting the final question of what it will cost to deliver the timber to the markets. The market price is the basis of the stumpage price, and the cost of getting the timber to the market regulates the scale of prices. For example, if the timber were worth at the mill $1.50 per standard, and the cost of delivery were $1, the stumpage price that could be paid would be 50 cents. If the timber could be delivered for 90 cents, the stumpage price would be 60 cents. The conditions which govern the lumbering of a tract regulate the stumpage prices. If a tract is very rough and precipitous with a small stand of timber, a long haul to water, and then a long and costly log drive before reaching market, the stumpage price would be lower than if the tract were comparatively smooth, with good skidding ground, a large stand of timber, short haul, and cheap log driving.

Market and consequently stumpage prices of Spruce and Pine in the Adirondacks have been steadily rising for some time, and especially of Spruce, because of the increased demand for Spruce pulp-wood. The increasing scarcity of timber lands, except those which are owned by the State or large corporations and those in private preserves, will likewise tend to maintain prices. As the growing scarcity of timber becomes apparent, millmen and manufacturers are vying with the State in getting hold of valuable timber lands, and of late there have been large investments in forest lands in the Adirondacks.

Township 40 is so favorably located for lumbering cheaply that the State would be justified in expecting the highest stumpage prices that are being paid locally at the time it is lumbered.

It was at first intended to furnish a complete list of railroad transportation rates to different markets in connection with the probable cost of lumbering each compartment in the township separately, this cost having a direct bearing upon the stumpage prices which could be expected. But it was found impossible to get satisfactory rates on something that might or might not be done in the future. As prices are constantly fluctuating, and as conditions which exist at present might be radically changed before it was decided to cut the timber on the tract, it was deemed better simply to quote the prices that could reasonably be expected for the stumpage at the present time.

The price of Spruce stumpage at present ranges from 40 to 55 cents per 19-inch standard, and should include the Balsam at the rate of 15 per cent of the Spruce. Letters received from many pulp manufacturers show that Balsam can be used in this ratio with satisfactory results. Balsam has long been included with Spruce stumpage under the same price, as should be done on this tract, cutting to the limits advised. In disposing of stumpage it is the usual custom to sell Spruce, Pine, and Balsam combined (sometimes including Hemlock and Cedar), these being the soft timbers which are commonly lumbered together in the Adirondacks. Pine stumpage is the most valuable and Balsam the least so, with Spruce between them. If there were an equal amount of each on the tract it would be fair to include them both with Spruce and let the Spruce price govern the whole. There is practically no market for Balsam unless sold with Spruce.

If the stumpage of Spruce, Balsam, and Pine were sold together on Compartment No. I at the present, it would probably bring 60 cents per 19-inch standard, as there is nothing to prevent this timber from being driven direct to markets downstream, and the stands of Pine and Balsam of the diameter limits advised for cutting are about equal on this compartment. (See Table No. 24.) There is a good log road already constructed from the point at which Brandreth Lake Outlet enters Township 40 down to Forked Lake. (See Map III.) This would add to the value of the stumpage by lessening the cost of the lumbering. It is quite likely that the State would be able to obtain 55 cents per standard for all the Spruce, Pine, and Balsam timber on the whole tract, sold together, if the improvements and concessions advised were made. But it must be remembered that prices are fluctuating, and that these estimates are good only for present conditions.

RULES FOR LUMBERING.

The application of the following rules will insure the safety of the forest. Its function in preserving the water-supply and as a public recreation ground will not be impaired by conservative lumbering, while its capacity as a producer of timber will be steadily increased.

In order to be certain that no timber below the advised limit for the different species is removed, and also in order to designate the trees so that there will be no possibility of the lumberman misunderstanding which trees he should cut and which he should not cut, it will be necessary to mark all trees intended for removal.

The diameter limits advised have been fixed after a thorough study of the effect of the cuttings upon the forest and the profits to be realized from the lumbering. Upon the care with which the markings are made and rules carried out the success of practical forestry upon Township 40 chiefly depends.

As has been stated (p. 33), smaller trees which show unmistakable signs of decay and death, but are still merchantable, or of which the tops have been broken off by falling trees or wind storms, so that it is clearly apparent that they will not live, should also be marked for removal.

Spruce, Pine, or Balsam trees, whose branches are so interlocked with valuable hardwoods or Hemlocks that they can not be removed without cutting the latter, should not be marked. They can be taken when the other species are marketed.

METHOD OF MARKING TIMBER FOR REMOVAL.

The method of marking trees adopted by the Division of Forestry is to blaze the butt of each tree intended for removal below the cutting point on the stump, with a hatchet, and to stamp the spot with the hatchet head, on which the initials "U. S." are raised. This symbol may, of course, be changed for State work. The marks on the stump will make it possible to determine afterwards whether any trees intended for removal were left, and also whether any were taken which were not intended for removal. The markers should brand all trees that are to be cut. It has been found that in marking timber the most satisfactory results can be obtained with a crew of three men. The usual custom is to take a strip through the forest, the men keeping abreast within easy speaking range of each other, marking every tree between them which is to be removed, and watching each other to see that no trees of the proposed limit or above are overlooked. The inside man follows the line of marks already made, and the others are guided by him. The man on the side next to the forest which has not been marked spots a hardwood tree occasionally, where there is not sufficient marked timber to serve as a returning guide line. It is estimated that a crew of three men can mark from 40 to 60 acres a day. The cost of marking on this tract should not exceed 15 cents per acre.

METHOD OF CUTTING.

There are but two methods of cutting timber in common use—chopping and sawing. Since sawing saves much timber which is necessarily wasted by chopping, it is strongly recommended for Township 40. It will be apparent even to those who are entirely unacquainted with lumbering methods that a tree felled and cut up with a saw yields more lumber than one cut with an ax. The kerf chopped out with the ax causes a loss in length of approximately one-half the diameter on the butt of each log. This being usually the best part of the log, it is very advisable to save it. For an illustration of the difference between the two methods of cutting see Pl. XI. What this difference would mean on this tract, on the Spruce alone, is approximately as follows: The average Spruce tree 12 inches and over at breastheight on Township 40 yields 1.26 standards if cut with the saw, as shown in Pl. XI, fig. 1. If cut with the ax, as in Pl. XI, fig. 2, it would yield only 1.19 standards, a loss of 0.07 of a standard per tree. If we assume that the total merchantable stand of 328,287 standards is contained in 260,545 trees with an average contents of 1.26 standards per tree if cut with the saw, then a loss of 0.07 standards per tree by chopping would mean a total loss of 18,238 standards for the whole tract. At 50 cents per standard this loss would reach $9,119. A greater number of cuts, made by cutting the timber in shorter lengths, would increase the loss proportionately.

It is the usual custom in cutting Spruce logs intended for pulpwood to cut them 14 feet 4 inches long. Each log then makes seven 2-foot lengths of pulp-wood, when cut up before "rossing." The four additional inches are to cover the necessary loss in cutting up and in trimming off the battered, discolored, and damaged ends of the logs, caused by driving them through rapids and over falls, and by their lying in the water until taken out for manufacture. If the logs were to be manufactured at Raquette Lake, 2 inches, or at the most 3, would cover all trimming, as the logs would not have to be driven through rapids or over large falls. An extra 4 inches, however, should be allowed on this tract for the lengths to which the softwoods are usually cut—10, 12, 13, or 14 feet, and also 16 feet when it is for the purpose of saving timber by bringing the cutting point in the top to the prescribed limit. This can always be done by varying the length of the log on the foregoing length scale. To allow any longer lengths than these to be scaled at the top end would cause a loss to the State, on account of the decrease in diameter as compared with timber cut 13 feet—the length upon which the scale rule advised is based. But if the timber were cut into 10- to 16-foot lengths, and the quantities

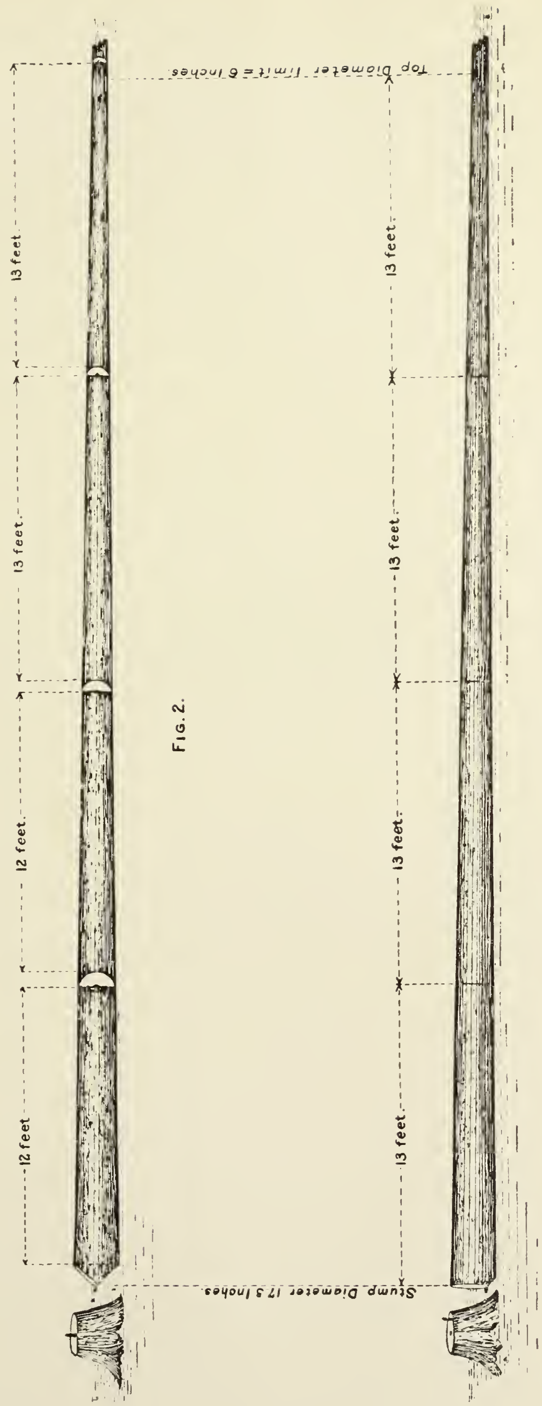


FIG. 2.

FIG. 1.

COMPARATIVE LOSS BETWEEN CHOPPING AND SAWING.

above and below the 13-foot standard length balanced, there would be no appreciable loss.

HEIGHT OF STUMP.

It is always important in lumbering to cut at the lowest point practicable. The timber in the butt is almost invariably of the first quality. It is clear and free from knots, and, if sound in the heart, is actually worth more to the manufacturer than any other portion. Very frequently the cutting of the tree at the lowest point practicable will considerably increase the scale allowed for the whole tree, because the slight difference either way in the height of the stump increases or decreases the diameter at the top of the logs. In the Adirondacks logs are scaled in even inches. Fractions of an inch below one-half are dropped, while any above are considered whole inches. Very often the diameter of a log is so near the one-half-inch point that the increase gained by cutting low is enough to put the log into the next higher inch class. These apparently slight differences in scale may at first glance seem of little importance, but in reality they can make or mar the profits of the average lumber job.

In verification of the above, we cite results of experimental measurements made in 1897 by Henry S. Graves, now Director of the Yale Forest School, and published by the Division of Forestry in Bulletin No. 26, entitled "Practical Forestry in the Adirondacks," page 59:

> Two hundred and eighty-three trees, which were measured in Nehasane Park in 1897, were scaled in standards. The taper of each log in each tree was computed, and it was determined what the diameter at the top of each would have been if the stump had been cut 18 inches above the ground.
>
> It was found that out of these 283 trees 78 would have actually scaled more in standards if low stumps had been cut. Computation was made of the percentage of increase in each tree affected, and of the ratio of trees of each diameter showing an increase to the entire number measured.
>
> The total increase for all the trees amounted to 5.4 standards. The total yield of the trees was 258 standards. The percentage of increase was, therefore, 2.1. The trees from which this computation was made were all sound. In actual practice a number of the trees are found to have some imperfection at the stump and a short piece has to be cut off. In generalizing from the above figures, therefore, an allowance should be made for trees of this character. It is believed that a reduction of 5 per cent is ample. The figure 2.1 per cent should be, therefore, 2 per cent.
>
> These figures mean that for every 100,000 standards removed, 2,000 are wasted by cutting high stumps. If a tract of 100,000 acres yields on an average 15 standards per acre there would be a loss in cutting high stumps of 30,000 standards. At a stumpage value of 40 cents per standard this represents an actual loss of $12,000.

If these figures were applied to Township 40, on which there are 410,263 standards of the species advised for removal, the saving would be, at a stumpage price of 50 cents per standard, $4,102.63.

It is claimed by some lumbermen that the cutting of high stumps economizes in the time and labor expended in the "butting," or cutting off, of that portion of the tree which is sometimes affected by heart rot, shakes, or other defects. But the tree can very seldom be cut high enough to remove these defects when found, and another cutting usually has to be made, and sometimes two or three, before the proper point to remove the defect is reached. It is impossible to judge with absolute certainty, from outside appearances, what the condition at the heart is, especially with regard to Spruce, and the foregoing theory could hold good only on very slightly affected trees, while all sound trees cut in this manner would be cut at a very appreciable loss. A foot in length saved of the clear timber in the butt of the tree, where the cutting-point diameter runs from 14 to 30 inches, as it does with the Spruce on this tract, is worth several feet in the top of the tree. There is not only the difference in the increased scale of the butt, but also the difference of the two extremes of quality—the clearest and best timber in the butt, and the smallest and most knotty in the top.

The cutting point can not be arbitrarily fixed for all conditions. Locality and the position of the trees with reference to large rocks, fallen trees, or other obstacles, tend to make this impossible. But it is recommended that no cutting more than 6 inches above the top of the root swelling be allowed.

DIAMETER LIMIT AT TOP END.

The following table, obtained by very careful measurements of 1,064 Spruce, shows in standards by Dimick's Rule how slight is the difference in scale of the top log gained by cutting to a diameter limit at the top end of 4 or 5 inches rather than 6 inches.

TABLE NO. 27.—*Difference in scale between cutting the top log to 4 or 5 inches and to 6 inches at the top end.*

Diameter breasthigh.	Number of trees analyzed.	Total gain by cutting to 5 inches rather than to 6 inches.	Average gain per tree.	Total gain by cutting to 4 inches rather than to 6 inches.	Average gain per tree.	Average number of trees per acre.
Inches.		*Standards.*	*Standards.*	*Standards.*	*Standards.*	
10 and over	1,064	3.39	0.003	4.06	0.004	23.40
12 and over	883	2.16	.002	2.52	.003	15.56
14 and over	602	.44	.001	.26	.0004	9.95

The average gain in the top log per tree 12 inches and over cut to 5 inches at the top end instead of to 6 inches is 0.002 standards. There is an average stand of 15.56 trees, 12 inches and over, per acre on Township 40. The gain per acre, cutting to 5 inches instead of to 6 inches, would therefore be 0.03112 standards. For the whole area of 16,896 acres this gain would be 525.80 standards, or only sixteen-hundredths of one per cent of the total yield of Spruce cutting to 6 inches.

It is true that if the purchaser of stumpage were to manufacture his own timber, the value to him of the additional material which the smaller limit would yield would be greater than the table indicates. But if the timber is sold by scale, as advised in this working plan, there would be no appreciable gain to the owner of the timber, though the forest would benefit by the removal of so much more of the objectionable tops. Further, all log buyers and dealers in pulp-wood object very strongly to any smaller diameter than 6 inches. With a diameter of 12 inches at breastheight, the top at 6 inches is sure to be about as far up in the limbs as the tree will have any commercial value, even for pulp-wood.

For these reasons it is advised that the Spruce and Balsam timber on this township be cut to a 6-inch limit. But it should be plainly understood that a 6-inch limit on Spruce means that the timber shall be actually cut to 6 inches in the top, and not cut to 7 or 8, as is usually the case, unless there should be some very satisfactory reason therefor. Should any timber over 6 inches in diameter at the small end, long enough to yield a 4-foot stick of pulp-wood, be left in the top, it should be scaled double as a penalty for not taking it at first. The length of the top logs can be varied by cutting them off at 10-, 12-, 14-, or 16-foot lengths, to bring the cutting point in the tops to the desired place on the trees. The tops might be cut to any smaller diameter by the contractor if he desired, but, if cut smaller than the limit, should be scaled at the limit. For example, if a Spruce log be cut to 5 inches at the top end, 16 feet long, it should be taken as a 6-inch log. This rule should be applied to the diameter limit on Pine, as far as practicable. A 10-inch limit at the top end is advised for the Pine. Pine logs are not considered merchantable timber, in the generally accepted sense of the word, when cut shorter than 10 feet in length and 10 inches in diameter at the top end. It will therefore be necessary in cutting the Pine to allow the lumberman to cut the logs into 10-, 12-, 14-, or 16-foot lengths, as the particular tree being cut may require. In order to save timber, every Pine tree should be measured to the required diameter limit at the top before a log is sawed off, and the length of the different logs should be varied on the above-mentioned lengths to bring the cutting point of the top log to the required diameter limit in the top of the tree. By so doing, much valuable timber would be saved, and if there were any visible defects in the tree they would be found before the cutting up commences and the lengths could be varied to remove them.

CARE IN FELLING, SKIDDING, AND IN CUTTING ROADS.

It is easily possible to save a large amount of the smaller growth on this tract by the exercise of a little care to fell the timber properly, and not to break down the smaller trees when it could as well be avoided by throwing the tree in the direction where there are the least number, or none, of the more valuable species growing. This should always be done when possible. The laying out of roads and skidways is another matter in which the exercise of reasonable care, while it means no extra cost to the lumberman, would accomplish a great deal in the preservation of the young growth. Many lumbermen make a very serious mistake by cutting too many roads for the area to be lumbered. They lose not only the cost of cutting out and leveling the roads preparatory to lumbering, but also that of clearing out for more skidways than are needed and of breaking out and fitting up more roads in the winter than are necessary for hauling. A winter of deep snows entails a consequent expense of shoveling the snow from the front and off the top of a large number of unnecessary skidways. These are not small items under certain conditions, as many lumbermen have found out to their sorrow.

Much unnecessary cutting and clearing out incident to making too many roads and skidways can be avoided by a careful location of the main roads and the building of no more branch roads than are absolutely necessary to reach the timber without skidding the logs too far, and also by building fewer and consequently larger skidways, whenever practicable, rather than many small ones. It is impossible to make a set rule for the distance logs should be skidded or the number of roads to be cut, both varying greatly with difference in topography. The proper location of roads should come under the direct supervision of the inspector in charge of the work, in whose hands, if he is competent for the position, these details may be safely left.

USE OF TIMBER FOR SKIDS, CORDUROY, AND BRIDGES.

In building skidways, corduroys, and bridges, the smaller hardwoods should always be used whenever it is practicable. Where there is no hardwood near by, the Balsam will almost invariably be found in sufficient quantity. Whenever possible one of these should be used for this work.

In building skidways, it has been found practicable and economical at times to cut from the trees intended for logs sticks of 2 or 3 log-lengths, as the holding capacity of the skidway may require, and to use them for skids until the logs are hauled off them in the winter. They should afterwards be cut into the proper lengths and hauled with the other logs. On account of the large diameter limit here advised for the cutting, it would be advisable to use that part of the tree nearest the top for this purpose, since it is lighter and easier to handle. At the same time it should be remembered that there is a decided advantage in using large, heavy skids, since, although it takes a little more time to get them into position, they do not require as much blocking up to raise them to the proper height in front, and the danger of the breaking down of a large skidway, after all the logs are carefully rolled upon it, is removed. The use of small Spruce for building skidways, corduroys, and bridges should not be allowed, unless it is impossible to find other timber of less value within a reasonable distance, a condition very seldom found in the Adirondacks. If small Spruce is used (except with the inspector's approval), it should be scaled at double value; for example, a stick 14 feet long and 6 inches at the top end should be scaled and charged against the person buying the stumpage as two such sticks. There should also be the distinct understanding that no smaller diameter limit than 6 inches will be figured, even on sticks of 4 inches in diameter, if cut from small trees without the consent of the inspector. This may seem at first glance a very hard rule to impose upon the lumberman; but a careful study of the conditions at present existing on all the lumbering operations that have been looked over makes it very evident that the inspector in charge of the proper lumbering of this tract should have a right of this kind. This is necessary in order to protect the State from the repeated small violations of the rules for lumbering, which, while hardly of enough consequence singly to warrant an open rupture or the breaking of the contract, would, if allowed to go on unchecked (as would be quite likely unless there was a small penalty of this kind which could be applied at once), very materially interfere with the proper lumbering of the tract. The enforcement of this rule would give the inspector in charge an opportunity to employ his own judgment in each case as to whether or not it were necessary to use small Spruce.

LOPPING TOPS.

There has been a great deal of discussion throughout the Adirondacks about the advisability of lopping tops when lumbering. Each side has its supporters. It is noticeable, however, that the owners of the land, and all who have a decided interest in the preservation of the forest, are usually in favor of lopping tops, while those who are opposed to it are almost certain to be either the persons who are compelled by contract or agreement to do the lopping, or some of their friends, who have taken the idea from them. There is no doubt that the proper lopping of tops is of great importance in the matter of checking forest fires. When the limbs are not lopped the tops are propped up from the ground by those underneath, and during a dry time in the early spring or summer, especially before the leaves are out, the small limbs and branches get exceedingly dry. If they catch fire in this condition they will burn very quickly, making a hot, flashy fire, especially when the tops are Spruce, Pine, Cedar, Hemlock, or Balsam. Where there are several tops lying together they will burn with a flash and roar that can be seen and heard for a considerable distance, often sending sheets of flame above the tops of small standing trees. These flames flash up through the branches of the resinous trees and usually set fire to them and kill them, while the added flame from the burning trees sets fire to the branches of others. When down tops are in this dry condition and are thickly spread over the ground (as is usually the case when cutting to a small stump diameter limit) the fire will run from one top to another, especially if a strong wind is blowing, just as it runs through dry, dead grass of wild meadows in the spring or fall. Even in swamps, where the Cedar had been cut and the tops were lying thickly spread about, the fire, impelled by a strong wind, has been known to run across as quickly as a man could, although the ground under the tops was wet and springy and would not burn.

When the forest is dry it has been found by all woodsmen almost impossible to check entirely a forest fire until it has run out of the territory of old cuttings, dead and dry tops, and slashes, or until rain has fallen.

For these reasons it is strongly advised that all tops on this tract not wholly broken by the fall be thoroughly lopped, in order to bring them to the ground, or near enough to it so that the first winter's snow will crush them down completely. They will then soon become wet and soggy, decay will set in much more quickly, and they will not burn in ordinary summers. The danger of fire, the greatest danger to the forest from lumbering, will thus be very materially lessened.

The cost of lopping tops varies greatly under different conditions and on different jobs. It is usually from 2 to 3 cents per standard, according to the diameter limit to which the cutting has been made and the thoroughness with which the work is done. It will be readily seen that if the top were cut off at a diameter of 8 inches more branches would remain to be lopped than if it were cut to 6 inches. Consequently it costs more to lop tops for an 8-inch diameter limit than for a 6-inch. On the same principle, the larger the stump diameter limit the less lopping of tops per standard, as it costs no more to lop the top of a tree containing two or three standards than it does one containing only one standard after the 6-inch point is reached. Therefore the cost of lopping tops on this tract, if cut to a 12-inch diameter limit breasthigh (which is practically 14 inches on the stump at the cutting point), would be less per standard than if they were to be cut to a 10-inch diameter limit, as there would be a much smaller number of tops from which to cut the limbs. The cost should not be above 3 cents per standard, or 15 cents per 1,000 feet B. M., and the lopping should be thoroughly done for that sum.

A little care exercised in the proper felling of a tree makes a decided difference in the work of lopping tops. If the tops are lopped immediately after the tree is felled, before other trees are felled upon it, the work can be done much more cheaply and with more safety to the young growth than if the lopping is made a separate job to be done after the cutting is completed. Later there will be many slashes, the cleaning out of which will add materially to the cost of lopping.

METHODS PREFERABLE FOR CUTTING ROADS TO THE LAKE.

The logging roads to the lake should reach the water as near the backs of the bays and the mouths of the inlets as practicable. No roads cut through the reserved strip along the lake front should be wider than is absolutely necessary to allow the passage of one loaded team at a time. No logs whatever should be skidded upon the shores of the lake. It would be impossible to allow the clearing out of a space large enough for the skidways and the consequent cutting of skidding roads and trails without causing more or less of an opening on the lake shore, which can just as well be avoided. Any roads which must be brought out at points where there are no streams coming into the lake should be made to come out to the lake with as short a curve as possible, and never in a straight line. The short curve will break the view of the cutting up the road, except for a very short distance, and will prevent it from being seen from the lake.

A little care in bringing out the roads properly and in keeping skidways away from the lake shores will prevent the lumbering from offending tourists and the summer traveling public, as well as the residents around the lake, who might not at first clearly understand its purpose and result. The proper arrangement of the shore end of the roads is as necessary to preserve the beauty of the landscape as the leaving of reserve strips along the lake shore.

SCALE RULE ADVISED.

Dimick's[1] 19-inch Standard Rule has been the basis for all estimates of the softwood timber on Township 40. This rule gives the contents of all logs in terms of a standard log, 13 feet long and 19 inches in diameter at the small end. The use of this rule in determining the amount of timber sold on Township 40 is strongly advised for the following reasons:

It is the rule best known and understood throughout the Adirondacks; and therefore it commends itself to the buyer and seller alike as a common scale which both parties understand perfectly. It is, in the opinion of a large majority of the lumbermen, millmen, manufacturers, jobbers, and contractors, the fairest rule for both buyer and seller.

A standard rule is preferred to a board foot rule in this case because most board foot rules give too small a scale to the small logs as compared with the larger ones. There will naturally be a large number of small logs in the tops of the trees on this tract, and as they bring, when sold with the larger ones, the same price per standard, it is advisable to use a rule which gives as nearly as possible the actual contents of the small as well as of the large logs. These requirements will be best served by the adoption of Dimick's Rule.

The Old Scribner Rule has been used in calculating the volume of the hardwood timber, because it is considered advisable to use a board foot rule for timber of this kind. This rule is more nearly accurate for the small logs than any of the others. It has been proved conclusively by manufacturers and millmen that neither the Dimick nor the Old Scribner allows more merchantable material for small logs than they actually contain.

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[1] Published by Crittenden & Cowles, Glens Falls, N. Y.

METHOD OF SCALING.

The method of scaling advised for this tract is the one in common use under Dimick's Rule—viz, measuring the diameter at the top end of the log. Its use is recommended, however, with the following provisions:—No Spruce or Balsam logs should be measured at the top end if cut more than 14 feet long (unless to save timber on account of breakage, forks, or defects), except such top logs as may be cut 16 feet long to bring them to the required top diameter limit. Pine logs over 14 feet long should be measured at the top end only when cut 16 feet long to save timber on account of breakage, punk knots, forks, etc., or to bring the cutting point to the desired top diameter limit. Any timber cut for dimension stuff, booms, spiling, or building material should be scaled at each 13-foot length when practicable. To scale long timber at the top diameter is not just, and would cause a serious loss to the State. When the timber is in such a position that the 13-foot points are not accessible, as when piled in skidways, every log should be measured at each end and the average of the two measurements taken as the diameter, and from it the contents should be found. The customary rule of accepting the diameter of the logs at the nearest full inch above or below the actual diameter should be followed.

No Pine logs should be culled or left in the woods that would scale 50 per cent or over of sound merchantable timber. Such logs should be scaled and taken at their actual merchantable value, both the end area of sound merchantable timber and the length of the log being taken into consideration. This rule is necessary in order that the State may not be the loser by careless or inefficient cutting, because much timber is sometimes wasted by slovenly work, especially in Pine.

Merchantable Pine timber should be construed in this case to be any timber that will cut sound boards of the minimum length of 10 feet.

Spruce or Balsam logs should be scaled and taken at their actual merchantable value whenever they do not contain more than 25 per cent that will not make merchantable pulp-wood. The incorporation of this rule would largely do away with careless and wasteful methods of cutting the timber, since no lumberman would continue to haul and drive logs under conditions involving this loss of scale. The scalers should be in the employ of the State and the number should be determined by the amount of lumbering going on. They should be selected wholly with reference to their capability and reliability, and they should be directly responsible to the inspector in charge of the work.

RULES FOR LUMBERING TO BE EMBODIED IN THE CONTRACT.

It is advised that the following rules be incorporated in any contract made for lumbering on Township 40. As has already been said, thorough supervision by trained men is absolutely essential to good results in the application of these rules:

1. All timber shall be cut with a saw whenever practicable.

2. No timber shall be cut in the reserved strips, except with the consent of the inspector.

3. All roads laid out through the reserved strips shall be approved by the inspector before any cutting is commenced.

4. No trees shall be cut which are not marked.

5. All trees marked shall be cut, unless a satisfactory reason is given for leaving them.

6. No trees containing merchantable timber shall be left lodged in the woods.

7. No trees shall be cut more than 6 inches above the swelling of the roots, unless a satisfactory reason is given.

8. All merchantable timber in the tree which is above the established diameter limit at the small end shall be utilized. If such timber is left, through carelessness or purposely, it shall be scaled double and charged at the stumpage rate paid for the timber.

9. No Spruce shall be used for bridges, corduroy, skids, slides, or for building camps or dams, unless the scarcity of less valuable timber makes its use absolutely necessary. Any timber unnecessarily so used shall be scaled double and charged at the stumpage rate.

10. All tops shall be sufficiently lopped to insure their being flattened to the ground by an ordinary winter's snow, the lopping to be subject to the approval of the inspector in charge.

11. All merchantable timber used for building skidways shall be cut into logs and hauled out.

12. Timber may be used for booms, but will be scaled and charged at the regular stumpage rates. Hemlock timber, if used for building purposes, shall be charged at the same rate as Spruce.

13. Contractors and lumbermen shall be careful not to do any unnecessary damage to young growth in lumbering.

14. The violation of any of these rules, if persisted in, shall be deemed a sufficient cause for annulling the contract.

INSPECTION.

The work of the inspector is of the greatest importance. Upon his capacity and judgment depends largely the proper lumbering of Township 40, or any other tract. The inspector should combine all the qualities of a first-class lumberman and a competent and impartial scaler, and should have a fair knowledge of practical forestry, besides the necessary energy to insure a careful and thorough inspection of all portions of the tract where lumbering is going on, enforcing the rules as thoroughly in out-of-the-way places as in those open to public scrutiny. He should have full control of the scalers and markers.

Any division of authority in the carrying out of the rules should be carefully avoided. The decision of the inspector should be final upon all matters connected with the lumbering.

He should make detailed reports to his superior officer of the number of pieces and standards scaled on each separate job, and of the general progress of the work at the end of each month. He should also furnish the lumbermen cutting the timber with a statement of the scale of the timber measured at least once a month while scaling is in progress, giving the number and contents of logs of each species.

NAMES OF TREES MENTIONED IN WORKING PLAN.

CONIFEROUS SPECIES.

Common name.	Botanical name.
Red Spruce	*Picea rubens* Sargent.
White Pine	*Pinus strobus* Linn.
Balsam Fir (Balsam)	*Abies balsamea* (Linn.) Mill.
Hemlock	*Tsuga canadensis* (Linn.) Carr.
Arborvitae (White Cedar)	*Thuja occidentalis* Linn.
Red (Norway) Pine	*Pinus resinosa* Ait.
Black Spruce	*Picea mariana* (Mill.) B. S. P.
Tamarack	*Larix laricina* (Du Roi) Koch.

BROADLEAF SPECIES.

Yellow Birch	*Betula lutea* Michx. f.
Sugar (Hard) Maple	*Acer saccharum* Marsh.
Beech	*Fagus atropunicea* (Marsh.) Sudw.
White Ash	*Fraxinus americana* Linn.
Black Cherry	*Prunus serotina* Ehrh.
Red (Soft) Maple	*Acer rubrum* Linn.
Silver (Soft) Maple	*Acer saccharinum* Linn.
Paper (White) Birch	*Betula papyrifera* Marsh.
Aspen (Poplar)	*Populus tremuloides* Michx.
Largetooth Aspen (Poplar)	*Populus grandidentata* Michx.
Wild Red (Bird) Cherry	*Prunus pennsylvanica* Linn. f.

UNDERGROWTH.

Striped Maple (Moosewood)	*Acer pennsylvanicum* Linn.
Mountain (Spotted) Maple	*Acer spicatum* Lam.
Witch Hobble	*Viburnum lantanoides* Michx.

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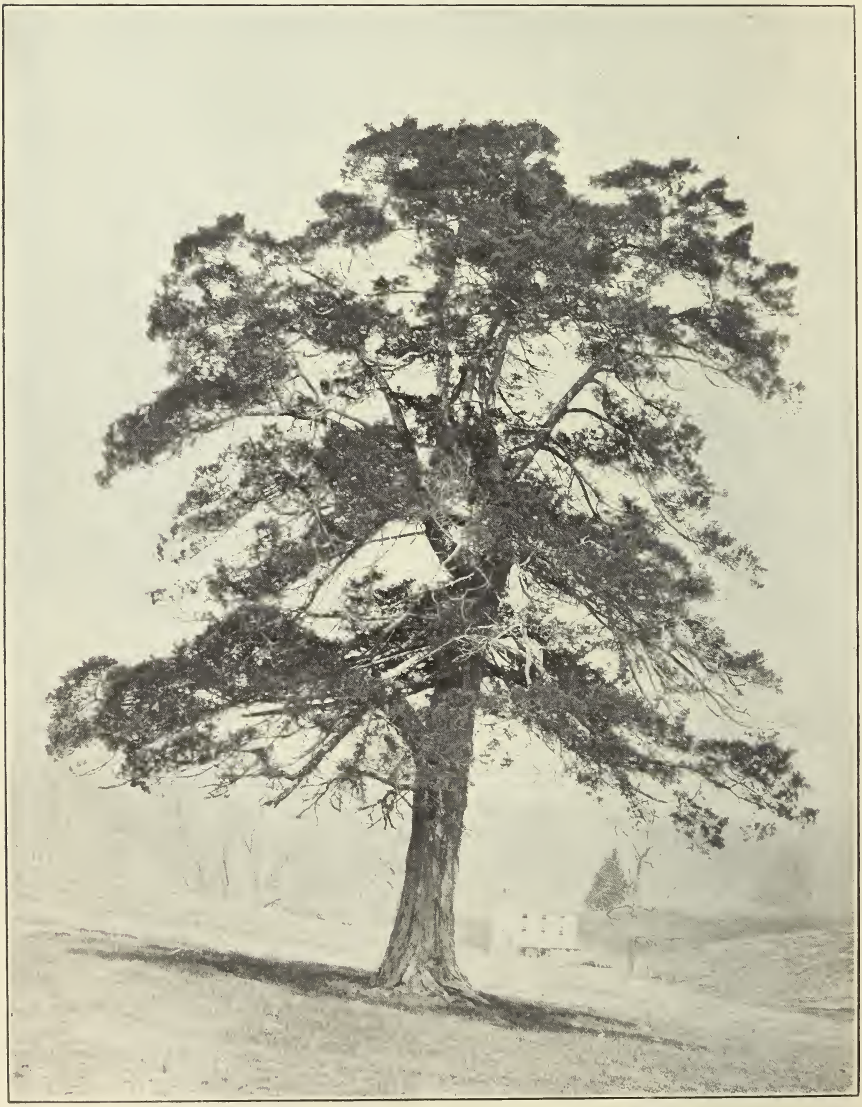

RED CEDAR (JUNIPERUS VIRGINIANA L.).

BULLETIN NO. 31.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF FORESTRY.
GIFFORD PINCHOT, Forester.

NOTES ON THE RED CEDAR.

BY

CHARLES MOHR, PH. D.,
AGENT IN THE DIVISION OF FORESTRY.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1901.

THE RED CEDAR.

Juniperus virginiana L. Spec. Pl., Ed. I, 2 : 1039. (1753.)

Synonyms:

Juniperus caroliana Mill. Gard. Diction., ed. VIII, No. 4. (1768.)
Juniperus arborescens Moench. Meth., 699. (1794.)
Juniperus barbadensis Michx. Fl. Bor. Am., 2 : 246. (1803.)
Juniperus foetida var. *Virginiana* Spach. Ann. Sci. Nat., II ser., 16, 298. (1841.)
Juniperus australis. Endl. Syn. Conif. 26. (1847.)
Juniperus sabina var. *Virginiana* Antoine Kupress., Tab. 83–84. (1860.)

LOCAL OR COMMON NAMES.

Red Cedar (New England, Middle Atlantic, and Southern States).
Cedar (Conn., Pa., N. J., Ky., S. C., Ohio, Ill.).
Savin (Mass., R. I., Conn., N. Y., Pa.).
Juniper (N. Y., Pa.).
Cedre (Louisiana).

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Division of Forestry,
Washington, D. C., April 25, 1901.

Sir: I have the honor to transmit herewith a paper by Dr. Charles Mohr, Agent in the Division of Forestry, entitled "Notes on the Red Cedar," and to recommend its publication as Bulletin No. 31 of this Division. With respect to forest management and the silvicultural characters upon which it depends, this paper is of necessity rather preliminary than final, and it is intended to supplement it hereafter by the results of a more detailed study of the Red Cedar in the field.

Respectfully,

Gifford Pinchot,
Forester.

Hon. James Wilson,
Secretary of Agriculture.

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NOTES ON THE RED CEDAR.

(*Juniperus virginiana* L.)

INTRODUCTORY.

The Red Cedar is one of the most widely distributed of our forest trees. It is, however, only upon comparatively small areas, confined to the southeastern part of the United States, that it is of the quality required for the purposes for which the wood is most highly esteemed. Its durability, coupled with other characteristics, has made it almost indispensable for certain uses. No wood is more frequently in the hands of civilized man of every station of life than the Red Cedar of his lead pencil.

The demand for Red Cedar is fast outstripping the supply. As it is a tree of rapid growth, thriving under many conditions of soil and climate, and on land fit only for timber, this species is of great value in the economy of our forests. The question of the reproduction and maintenance of Red Cedar is, therefore, of no little practical importance.

HISTORICAL.

The Red Cedar attracted the attention of the first students of American botany, and of authors before the time of Linnæus, as well as of European horticulturists. The tree was already established, shortly after the middle of the seventeenth century, in English gardens and upon the continent of Europe. The value of its wood was recognized by the earliest writers on the products of North American forests. Wangenheim praised it as one of the most valuable and useful of timbers. He said:

> It can justly be said that its usefulness extends from the bottom to the top, its red heartwood remaining unaffected by decomposition and by worms, and resisting equally decay under exposure to the atmosphere, to water, or to the ground.[1]

The same writer says further that large sticks of this timber were sawn into planks used in shipbuilding, that the smaller were used for posts, and that these articles were the objects of a considerable trade.

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[1] Wangenheim, Beschreibung Nord Americanischer Holzarten (1781).

Thirty years later A. F. Michaux wrote:

> This useful wood is procured with difficulty and reserved only for the most important purposes, its reproduction being trifling in comparison with the consumption in the United States, particularly in the cities of New York, Philadelphia, and Baltimore. Its use in naval architecture, more than any other, has wasted the species, so that recourse must now be had to the coast of Florida between the St. Marys and St. Johns rivers, which will soon be exhausted in its turn.[1]

DISTRIBUTION.

A. F. Michaux found the northern limit of Red Cedar on the Atlantic coast in southern Nova Scotia, and in the interior on Lake Champlain. Toward the west the tree extends under nearly the same parallel (44° to 44° 30′ N.) to the southern shore of Georgian Bay, to northern Michigan, southern South Dakota, western Nebraska and Kansas, and southward to the eastern bank of the Colorado River, near Austin, in Texas.

As has been shown recently by Prof. C. S. Sargent, the Red Cedar of the West, formerly considered identical with that of the East, is a distinct species, for which he proposed the name *Juniperus scopulorum*. *Juniperus virginiana* does not extend farther west than the basin of the Mississippi River in the North, and the eastern slope of the Colorado Valley in the South.

With the recognition of the tree of the Gulf shore and eastern Florida as a distinct species—*Juniperus barbadensis* (Pl. II)—the southern limit of the northern Red Cedar, *Juniperus virginiana*, has become somewhat obscure, as it still remains doubtful whether the latter is indigenous to the coast region of the Gulf States, where it occurs together with the subtropical species. From what is known at present, it appears most probable that the species finds its southern limit on the coast in lower South Carolina, and westward on the limestone hills in the upper division of the maritime pine belt in Alabama and Mississippi. (See Pl. III.)

There is scarcely another tree of the East which exhibits a greater indifference to soil and climate than the Red Cedar. It thrives in the valley of the St. Lawrence and in New England; on the hills and limestone flats of the Southern States; on the exposed, arid ridges of Kansas and Nebraska; and on the deep soil of the hummocks of the Gulf coast, where the annual precipitation is 60 inches. It is, however, south of the thirty-sixth parallel that Red Cedar is at its best. It can, in general, be said that the tree requires for its best growth a rather light, loamy soil, containing lime; and that heavy clay and sand are not favorable to its development.

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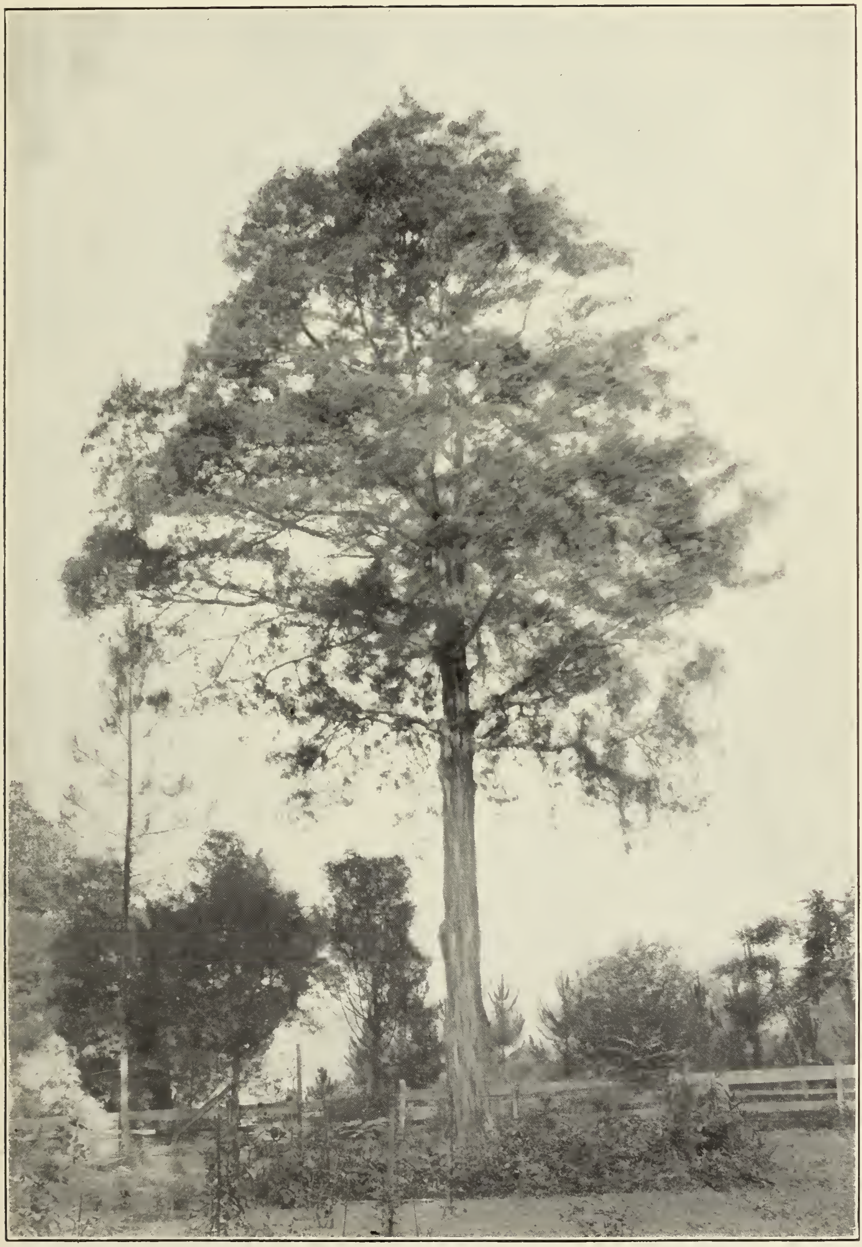
[1] A. F. Michaux, Histoire d'arb. forest. de l'Amériq. septen. 1810; and Philadelphia Edition, Vol. VIII, p. 173, pl. 155. 1857.



RED CEDAR (JUNIPERUS BARBADENSIS L.).

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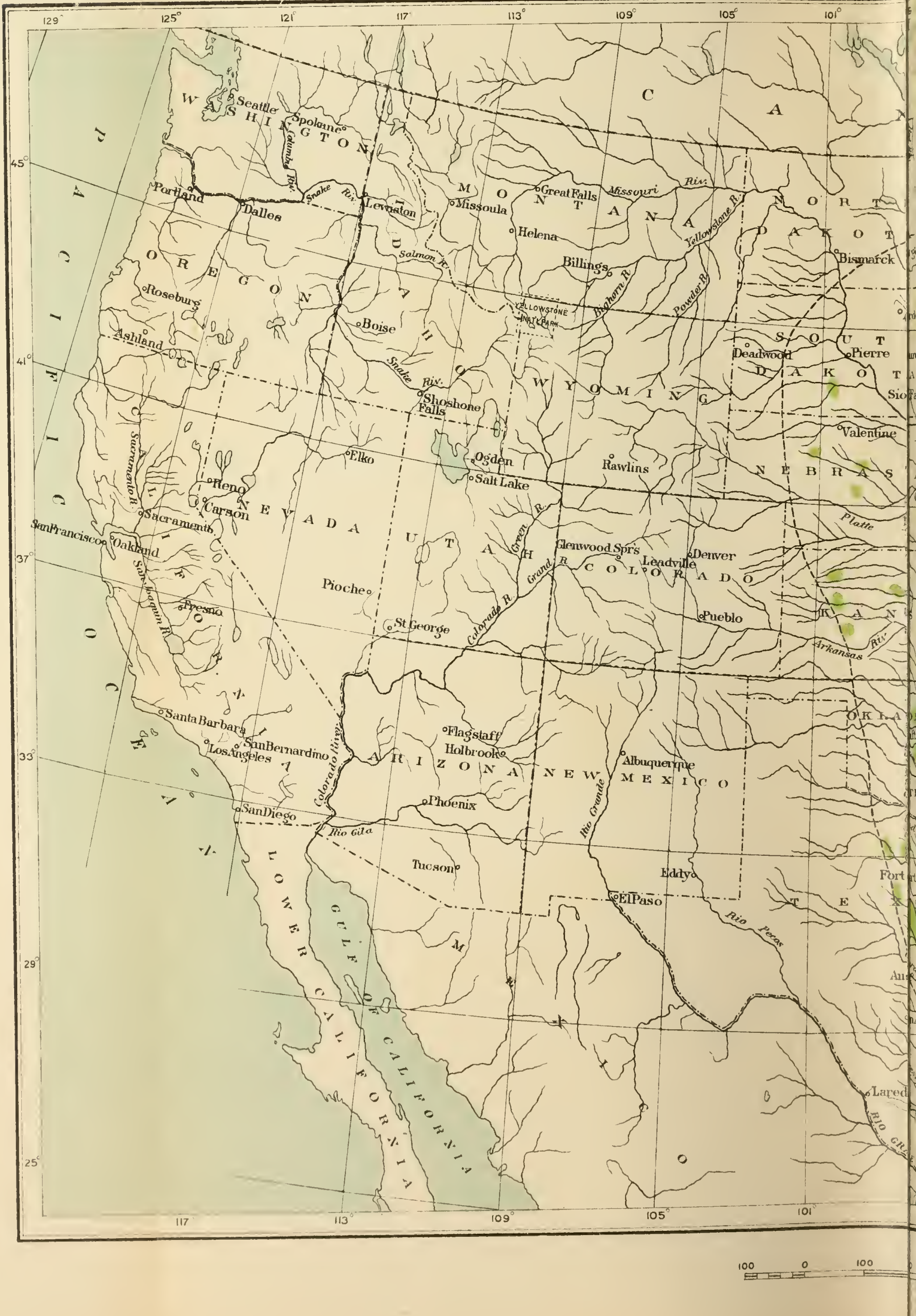
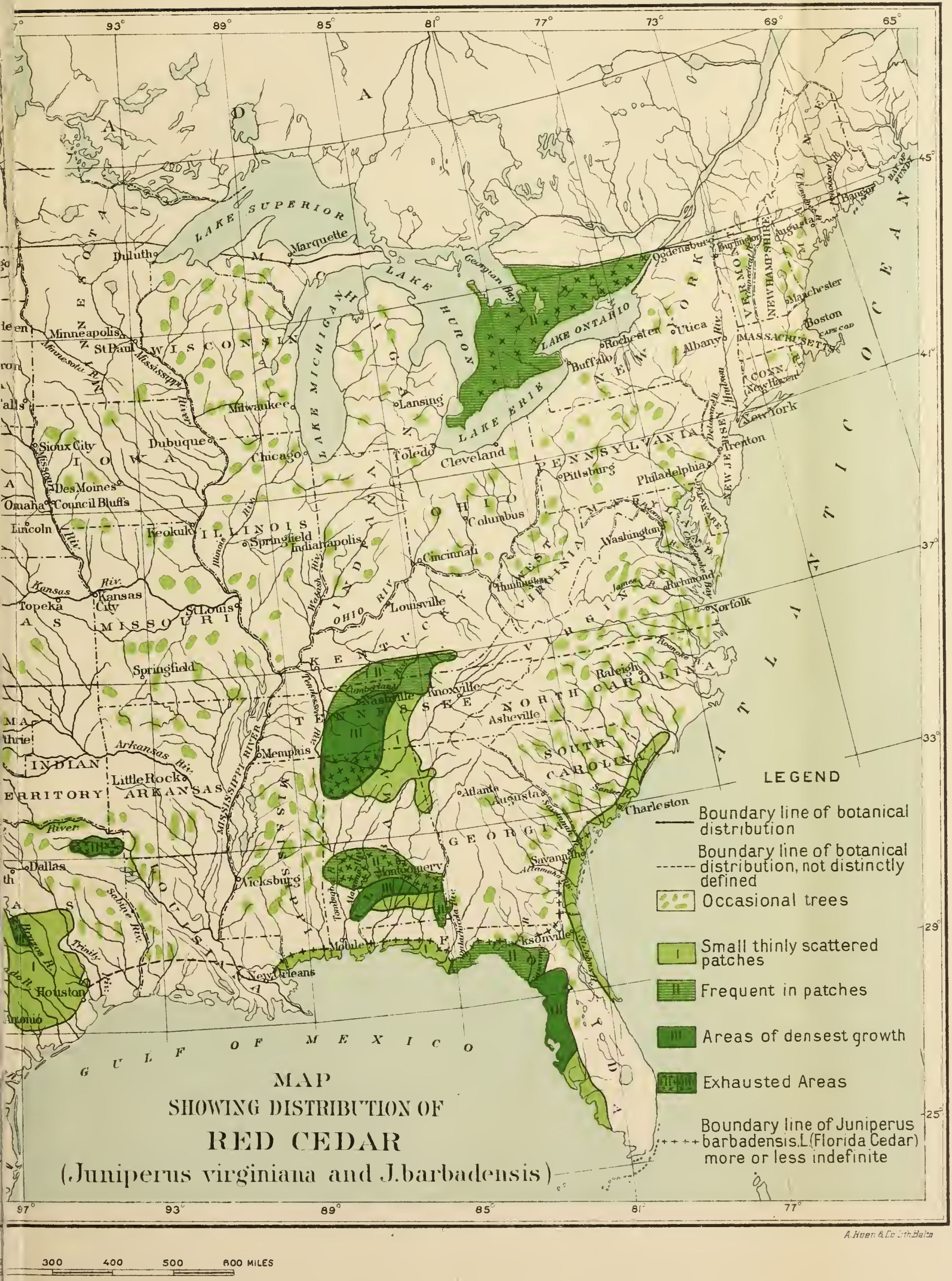


PLATE III



MAP
SHOWING DISTRIBUTION OF
RED CEDAR
(Juniperus virginiana and J.barbadensis)

A.Hoen & Co. Lith.Balto

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ALABAMA.

The Northern Red Cedar prevails most extensively in this State in the basin of the Tennessee River, and among the foothills of the mountain region. These valleys have been almost entirely stripped of marketable timber. The best trees are found scattered in the hardwood forests of the coves, on the declivities of the Warrior table-land, and in the narrow valleys intersecting the ridges of the Cumberland Mountains on the north side of the Tennessee River. Examinations made in the coves about Falkville, Morgan County, and elsewhere, show that Red Cedar formed originally 20 to 30 per cent of the forest growth. On the slopes and the benches, and in the narrow valleys with a calcareous, fresh, and fertile soil, the trees are large and the trunks free from knots, furnishing timber best adapted for hollow ware and for pencil wood. On the dry ridges of limestone rock which form the foothills, Red Cedar occurs almost pure. In such localities the stand is dense, and the trees are used chiefly for telegraph poles and piles.

The forests and cedar glades of the Tennessee Valley, with Falkville, on the Louisville and Nashville Railroad, for one of the principal shipping points, furnished for the last fifteen to eighteen years the larger number of the telegraph poles required in the lower Southern States by the Western Union Telegraph Company, amounting on the average to about 175,000 poles per year. Fifteen hundred carloads, averaging 65 poles each, and valued at $146,000, were shipped from Falkville during the year 1890 for this company alone. The number of poles of smaller size, used to support electric wires and for piling, shipped during the same period was scarcely less. No figures could be obtained of the timber used in the manufactories of pencil wood and hollow ware, in operation in the valley. The telegraph poles required by the above company were of the same dimensions as the poles which reach the market of Nashville. On counting the annual rings of a number of them, they were found to have been taken from trees 120 to 160 years old. The depletion of the forest near the railroad has been proceeding at a rapid rate ever since. Of late years the timber has been hauled for long distances over the rough mountain roads. A visit to Falkville, in 1898, showed that the traffic in Red Cedar had entirely ceased, owing to its exhaustion in this part of the Tennessee Valley. In the narrow valleys and on the lower hills north of the Tennessee River, more difficult of access, Red Cedar is said to be still abundant. The frequency of the tree on the hills depends largely upon the nature of the soil. Wherever the strata of the Subcarboniferous limestone are overlapped by the silicious conglomerates and sandstones of the coal measures there is practically no Red Cedar.

The increasing scarcity of commercial Red Cedar along the railroads north of the Tennessee River was shown by the removal, a few years ago, of the cedar-pencil works at Gurley. East of the oak barrens, from the western boundary of Madison County, the limestone forms extensive flats covered with Red Cedar. On these dry cedar barrens the trunks of the old trees are knotty from the base, and the wood is hard and brittle. This inferior quality of Cedar finds a ready market for fencing. In Jackson County these cedar barrens occur in patches, frequently of large extent. On the rugged limestone hills, unsuitable for the cultivation of crops, Red Cedar finds a safe retreat. After the merchantable material has been cut out, the younger, more or less suppressed trees grow rapidly, and seedlings and saplings easily hold their own against hardwood trees and deciduous shrubs. In the localities rarely exposed to fire, it is likely that before another half century has passed these forests will again yield merchantable timber.

Before the fertile lands of the central prairie belt of Alabama were cleared, its forests teemed with Red Cedar of superior quality. Only a comparatively small portion of these magnificent forests is now standing, the largest area still untouched lying between the Alabama and Tombigbee rivers. A remnant of a forest of Red Cedar and hardwood near Gallion in Hale County offered a good opportunity for the study of the condition of the cedar hummocks in their original state. The land covered by this forest is undulating, with a deep, rich, loamy soil. The stand is dense, and consists chiefly of Elm, Beech, Sugarberry (*Celtis mississippiensis*), White Ash, Sweet Gum, and Durand Oak (*Quercus breviloba*), with Red Cedar scattered among them. The latter forms from 35 to 40 per cent of the tree growth of these forests. Young Cedars occur frequently in the undergrowth, particularly in the openings. This young growth promises, however, little for the future, for it is stunted by the tramping and browsing of cattle.

In the upper division of the coast pine belt, particularly on the so-called hill prairies, where Tertiary limestone is the surface formation, Red Cedar furnishes large supplies of timber of high quality. On the arable lands of this region the forest trees have in a great measure disappeared, and it is only in the highly broken and rocky lands, too remote for ready transportation, that larger tracts of virgin timber have escaped the ax, as, for example, in the northwestern part of Butler County and the adjoining parts of Wilcox County. On the upper slopes and the crest of the hills, Red Cedar, which is here associated with Chinquapin Oak, Yellow Oak, Black Gum, Hard Maple, and Basswood, forms fully one-third of the timber growth, while on the lower slopes, where it is associated with Magnolia, Cucumber-tree, White Ash, Cow Oak, and Texas Oak, it is of large dimensions and forms fully one-half of the stand. Fallen trees were found from 90 to 100 feet high, clear of limbs for two-thirds of their height, and 2 feet and over in diameter $4\frac{1}{2}$ feet above the ground. Trees of this size are frequent, and several within sight at one time measured 30 inches in diameter breasthigh, their tall, tapering trunks ending in a slender, spiry top. A good many of the old trees are unsound at base, and many have been thrown by wind. It is said that the wood of such trees has become softer than that of standing trees, and is, therefore, more valuable for pencils.

Young saplings and seedlings of Red Cedar seldom occur in the forests of these hill prairies. After the removal of the marketable trees, the ground, wherever cultivation is practicable, is almost immediately cleared. The forests about the headwaters of Cedar Creek furnish the supplies to the Gulf Red Cedar Works, situated on the Louisville and Nashville Railroad. For the past few years these works have been engaged exclusively in the manufacture of pencil slabs, which permits of the closest utilization of the highly defective timber. The waste resulting from defects due to decay and perforation of the wood by insects is said to be fully 60 per cent of the material sawn. The timber reaches the mills in lengths of about 25 feet; the logs vary in diameter from 15 to 24 inches and over at the butt, those of from 15 to 20 inches in diameter being most numerous. Logs of such dimensions show from 116 to 160 annual rings at the butt end, and a sapwood from one-half to 1½ inches wide. The number of rings in butt logs 20 to 22 inches in diameter varies between 160 and 180.

The cedar forests in Butler County are under the control of the company which owns the works just mentioned. They are connected with the works by a well-equipped railroad, which assures to this company regular supplies of timber for a number of years to come.

Outside of the hill prairies Red Cedar is scattered irregularly through the hardwood forests of the upper division of the maritime pine belt, which crosses Alabama with an average width of from 30 to 35 miles. All the hewn red cedar logs which are rafted down the Mobile and Tombigbee rivers to Mobile are brought from this region. The amount of such timber shipped annually to this market can not be stated, as the receipts are included under the head of "Hewn timber other than pine." Nothing is known of the amount for home consumption received at this port. Smaller shipments of Red Cedar are made to Pensacola and Bagdad, in western Florida, where they are used in the manufacture of boards, pickets, etc., for the export trade.

In the coast plain of Alabama, and in the same region from Florida to eastern Louisiana, this tree was a favorite with the early settlers to shade and embellish the grounds near their dwellings. Trees from 60 to 100 years old and over are still found in the suburbs of the cities and in hamlets on the coast. These trees, grown in the open, present a habit of growth strikingly different from that of the forest tree. The sturdy trunk, 2 to 3 feet and upward in diameter, divides at about 20 feet above the ground into heavy, wide-spreading limbs with numerous branches and drooping, slender branchlets, forming a dense head of a roundish or broadly oval outline.

Trees in every stage of growth are found along fences and hedge rows and the borders of woodlands. Red Cedar of the same spreading form occurs frequently in the valleys, on half-swampy hummocks along the watercourses. The cultivated trees in the open are of quick growth. Felled trees observed in Mobile, from 12 to 13 inches in diameter breasthigh, the trunk free from limbs for 15 feet, and with a total height of from 50 to 60 feet, were found to be from 50 to 60 years old. The trunks of these trees are frequently hollow in the center, and the timber is fit only for posts, which find a ready market.

The ancient shell heaps, or shell banks, which border the numerous inlets of the sea, are frequently covered with patches of Red Cedar of low, spreading growth. Although the soil of these shell banks is fertile and to all appearances favorable to the tree, it often remains stunted when exposed to high winds.

FLORIDA.

Red Cedar is found in all parts of Florida, but is at present abundant only on the western coast, especially in the large swamps, of which the Chesahowitzka, or, as it is frequently spelled, "Chesawiskey," and the "large Gulf hummock" are the best known. Mr. Filibert Roth, who has investigated the cedar hummocks in this State, furnishes the following information on the subject:

> In the wet swamps of eastern Florida and all sandy pine lands the Cedar is wanting. It occurs in eastern Florida only in the more fertile, half-swampy forests, where it is thinly scattered, mostly as old timber with little or no young growth, among the hardwoods and Palmetto, which, often with a sprinkling of Cypress and Loblolly Pine, cover these hummock lands. On the western side of the peninsula it is also restricted to the hummock lands and swamps. On the whole, more than 1,000,000 acres, or about 50 townships, with probably an average of a hundred cubic feet per acre, or a total of about 100,000,000 cubic feet, can be assumed to have been standing in Florida. At present it is believed to be largely cut out, and the supply reduced to little over 10 per cent of the original stand; 75 per cent of this must be looked for on the western hummocks. The tree occurs scattered among the hardwood timber, forming small groves by itself, and, as the predominating tree in the mixture, commonly covers considerable tracts in the western swamps. It is generally 40 to 50 feet in height (rarely more), quite straight, with a taper of 4 to 5 inches in the first 16 feet; the stump is generally not over 20 inches in diameter, rarely 3 feet.
>
> The logging is carried on in a very primitive way. The supplies at the mills more resemble piles of ordinary cord wood than saw timber, and the methods are very economical, there being no waste of sound material. The average yield per tree is about 20 cubic feet, and per acre, when large areas are considered, about 100 cubic feet. In eastern Florida the red cedar hummock has completely disappeared from many localities. In the western swamp it is claimed that the ground might be logged over every fifteen or twenty years. Although this is hardly correct if the logging were done thoroughly, it is nevertheless certain that judicious lumbering need never exhaust the supply of Red Cedar, and might increase many-fold the present yield.

GEORGIA.

Small tracts of commercial Red Cedar are found scattered in the valleys of northwestern Georgia, where limestone is the surface formation. In Mississippi and Louisiana the tree occurs too sparingly to be of commercial importance.

NEBRASKA.

In this State Red Cedar is common, and is found as far westward as Sioux County. In some localities trees 2 feet in diameter have been observed.[1]

NEW ENGLAND.

South of the Kennebec River the tree is more or less frequent upon the lower hills and in the valleys. It is common in old clearings and deserted fields, varying greatly in form and size, according to soil and exposure. Emerson described the tree when growing on the seashore and exposed to the wind as gnarled and twisted in form and seldom more than 20 inches in diameter.[2]

NEW YORK AND ADJOINING STATES.

In the upper valley of the Hudson and the northern and western parts of New York, and in adjoining parts of Pennsylvania, Red Cedar is frequent, and it is also common in northern and central New Jersey. It is, however, of inferior quality, fit only for posts. The wood is hard and brittle, of uneven and knotty grain, and is rarely of use in the mechanical arts.

TENNESSEE.

South of the Ohio River Red Cedar is found in greatest abundance and furnishes its best timber. Although most plentiful on the dry limestone flats of middle Tennessee and northern Alabama, it forms also a large proportion of the tree growth in the damp valleys of this region.

Red Cedar occurs throughout Tennessee, but is most abundant in the basin of Silurian limestone of middle Tennessee. Dr. A. Gattinger finds that in middle Tennessee Red Cedar covers patches from a few acres to several square miles in extent, which are the remnants of the cedar forests which originally covered a large part of this fertile region. The virgin growth of Red Cedar has for the most part disappeared with that of Black Walnut. Mr. Sudworth says that the tree was common, and its virtue of outlasting men and things well known, as evinced by the miles and miles of gray-brown rail fences of good Red Cedar looking hundreds of years old.[3]

According to Dr. Gattinger, Red Cedar occurs in groves in the counties of Wilson and Rutherford. The first of these is eminently a red cedar county. The town of Lebanon stands on a red cedar flat. It was observed by Mr. Sudworth that a large amount of the Red Cedar left is young growth, with low-branched crowns and trunks too small for telegraph poles, but useful for fence posts. There are also small bodies of prime old Cedar left in nearly all of the counties of middle Tennessee, which have escaped the attention of the hunter for pencil cedar.

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[1] Herbert J. Webber. Catalogue of the Flora of Nebraska, p. 96.

[2] Emerson. Trees and Shrubs of Massachusetts.

[3] George B. Sudworth. Forest Flora and Conditions of Middle and East Tennessee: an address delivered at the autumn meeting of the American Forestry Association, held in Nashville, September 22, 1897.

The virgin Red Cedar is often several centuries old, and in some cases very large. Mr. Sudworth was shown fine sound timber averaging about three 5-foot logs to the tree. One butt log squared 37 inches, with an estimated age of 290 years.

Dr. Gattinger says also:

> The principal cedar market is Murfreesboro, the large supplies of Red Cedar reaching this place by the eastern branch of the Louisville and Nashville Railroad from Bellbuckle, Normandy, and Montrose. A line run parallel with the Chattanooga and Nashville Railroad comes near to giving the eastern limit of the cedar belt. Here the oak barrens set in, underlaid by the Devonian and silicious Subcarboniferous strata. The counties west of that line are only dotted with lesser patches of cedar glades.

According to the same observer, several large supplies of first-class red cedar poles formerly reached the city of Nashville by the extension of the Nashville, Lebanon, and Cumberland Mountain road. These poles averaged about 50 feet in length and from 18 to 24 inches in diameter at the butt. They sold for about $3 apiece; and in this shape Red Cedar is said to be disposed of at the greatest profit. Good red cedar lumber sells in the market at Nashville for 8 to 10 cents a foot, board measure. Mill men find the cost unprofitably increased by the many defects common to this timber.

In Marshall County Red Cedar, associated with hardwood trees, forms a large part of the forest which covers the valleys and the lower slopes of the hills. It occurs in nearly pure woods on the broad, dry limestone flats, with only a shallow covering of soil, which extend throughout central and southern Tennessee eastward to the Tennessee River. The timber is more or less stunted and knotty, and serves largely for fence posts.

It is probable that, at the present rate of consumption, the supplies suitable for the manufacture of hollow ware, pencil wood, and lumber will be exhausted within a few years.

TEXAS.

Originally Red Cedar was frequent in the central limestone region of the State. Before the end of the first half of the nineteenth century the earlier settlers found it in abundance in the Brazos Valley, and more or less scattered on the limestone ridges east of the Colorado River. At present it is practically extinct all over this wide extent of country. Professor Sargent considers the valley of the Red River from the border of Louisiana as far west as Clarksville as the region where the tree reaches its best development.[1] From the observations of the writer, made in 1894, commercial Red Cedar has become scarce in this valley, only inconsiderable quantities reaching Texarkana, where they find a ready market.

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[1] C. S. Sargent, Garden and Forest. 10:420. 1897.

So far as could be determined from the scanty material examined, the Red Cedar of eastern Texas is identical with the northern tree.

DOMINION OF CANADA.

Red Cedar is considered a comparatively rare tree in the Dominion of Canada, where it is confined to the limestone shingle along the River St. Lawrence and Lake Ontario. In the Bay of Quinte district, according to Prof. J. Macoun, many groves of considerable extent are found, which covered, as late as 1883, large areas along the lake shore and in the Niagara peninsula. The timber from this region is of inferior quality, and a large proportion of the trees are diseased. Professor Macoun reports that all the valuable Red Cedar in these districts has been cut.

ASSOCIATED SPECIES.

Owing to its wide distribution, Red Cedar occurs in mixture with many other trees.

In districts where the limestone is scarcely hidden by the shallow soil covering, as, for example, on the cedar barrens of middle Tennessee, Red Cedar forms an almost pure stand over large areas; on the rocky hills of the Tennessee Valley, with a moderately fresh soil, it is the predominating tree in mixture with, principally, Small-fruit White Ash (*Fraxinus americana curtisii*), Blue Ash (*Fraxinus quadrangulata*), Hard Maple, and White Oak. In the rich forests of the cretaceous plain of Alabama it is mixed with Beech, Sugarberry, maple, Shagbark Hickory, Pignut Hickory, Yellow Oak, and White Oak, and forms 20 to 40 per cent of the stand. In the hill prairies of Alabama, the Cedar, mostly of large size, is, on the lower slopes of the hills, associated with Magnolia, White Ash, White Basswood (*Tilia heterophylla*), Wing Elm, Post Oak (*Quercus minor*), and Mockernut Hickory; and on the upper slopes of drier soil, with Chinquapin Oak (*Quercus acuminata*), Ironwood (*Ostrya virginica*), Yellow Oak (*Quercus velutina*), Black Gum, and small Black Walnut. In eastern Florida it often occurs in mixture with Bald Cypress and Loblolly Pine, among hardwoods and Palmetto. Red Cedar predominates on the swampy hummocks on the western coast, often to the exclusion of other species. In the cedar glades of the Tennessee Valley young Cedar forms a large part of the undergrowth; it also abounds in the openings of the cedar hummocks in the prairie region of Alabama. It is rare, however, on the steep slopes of the hill prairies farther south.

PRODUCTS OF RED CEDAR.

The northern and southern species present no essential differences in the appearance and properties of the wood, and are not distinguished by the consumer.

The durability of Red Cedar, its lightness and softness, the ease with which it is worked, its compact, fine, even grain, and its susceptibility to a high finish, combined with a pleasing color and a strong fragrance, give it a wide range of application in naval construction and in various mechanical arts and industries.

Its great resistance to decay renders the timber of Red Cedar highly valuable. Its durability was recognized by the earliest settlers, who used it largely for house building. At present the heaviest drafts upon the supplies of Red Cedar are made for poles, piles, and cross-ties, for all of which its capacity to resist the effects of the weather render it especially suitable. To a lesser extent Red Cedar is employed in boat building and for furniture.

Large quantities of timber of higher grade are consumed in the manufacture of small cooperage, such as buckets, churns, and tubs. It is to be regretted that no estimates could be obtained of the amount of Red Cedar used every year in this industry, and of the value of the annual output of the chief manufactories of cedar ware in Virginia, North Carolina, Tennessee, and Alabama, owing to the fact that the same articles are made of White Cedar ("Juniper"), and the product of both indiscriminately included under the head of "cedar ware."

The production of the wooden case inclosing the rod of black lead which forms the lead pencil has attained truly astounding proportions, and the rapidly diminishing supply of red cedar wood especially adapted to this purpose is becoming a matter of serious concern to the firms engaged in the manufacture of pencils. Only wood of great softness and of straight, even grain, free from knots and defects, can be used for pencils. On request for information upon the subject, one of the largest firms engaged in the manufacture of lead pencils stated that fully 500,000 cubic feet of red cedar wood, the product of at least 125,000 trees, are in this country alone annually consumed in the manufacture of lead pencils, and, further, that about 75,000 cubic feet of the timber are yearly exported from the United States. The cedar wood from Florida is considered the best, and until lately three-fourths to seven-eighths of the world's supply of pencil wood was furnished by that State. Since the timber of many of the cedar hummocks has been exhausted, the supplies existing in the adjoining States, particularly in Alabama, southeastern Tennessee, and the Red River region in Texas, have been resorted to. Now the cedar woods in the center of Alabama and in the Tennessee Valley are rapidly on the wane. The cedar mills have already been shifted to new fields, and it will be but a few years until they have used all the Cedar within reach.

At the pencil-wood manufactory near Greenville, Ala., the logs are cut in sections 2½ feet long and sawed lengthwise into boards from one-half inch to 3¼ inches thick, which in their turn are cut to the length of 7½ inches; they are then cut into slabs three-sixteenths of an inch thick, and finally into pieces of the standard widths of 2¼ inches and less (1¾, 1½, 1, and six-eighths of an inch), as the soundness of the material will admit. Assorted according to these five sizes, 100 gross of the slabs are packed into square wooden cases for shipment.

The waste of the sawn wood is often converted into fine shavings, like excelsior, and used in place of camphor and naphthaline to protect woolen goods and furs. The waste of the cedar mills is also manufactured into paper for underlaying carpets and for wrapping furs. Quantities of Red Cedar are used in Germany for cigar boxes.

The leaves and young twigs of Red Cedar furnish a volatile oil, which is sold to the drug trade, and brings about 20 cents a pound. A similar product is distilled from the wood, but it is of inferior quality and brings about half the price.

WOOD OF THE RED CEDAR.[1]

SAPWOOD AND HEARTWOOD.

The sapwood is always narrow, commonly five-eighths to 1 inch thick. The number of rings in the sapwood varies with age and rapidity of growth; 20 to 30 rings are counted in old, slow-growing trees, and from 8 to 15 in younger trees of thrifty growth. It is of a dingy white color. The heartwood is of a bright pinkish red, which

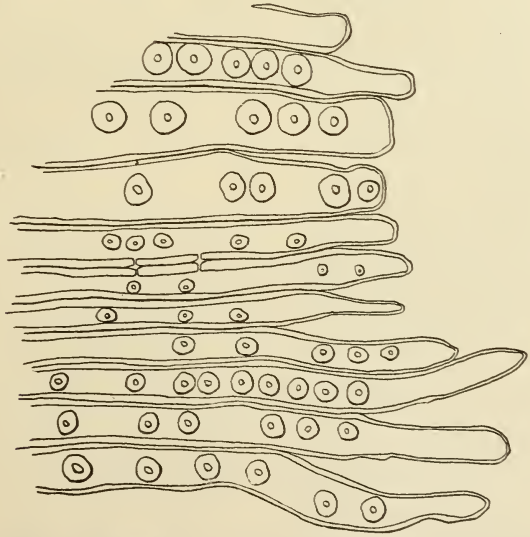

Fig. 1.—Radial section of inner wood: A number of cell endings, showing their arrangement, relative size of pits, and the pits of the tangential walls in the last cells of the summer wood—greatly enlarged.

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[1] The discussion of the wood of Red Cedar has been contributed chiefly by Filibert Roth.

changes with age to a deep reddish brown. In defective wood it is not uncommon to find the heartwood in streaks and spots out to the bark. Frequently the color of the heartwood near the sap is much brighter than farther in, and often it is not uniform, but shows a mingling of bright red and brown tints.

The wood is of an even, straight grain and is compact, owing to the numerous small, faint medullary rays. It resembles in this respect the wood of White Cedar (*Chamaecyparis thyoides*), which is, however, at once distinguished by its white color and want of strong fragrance. The spring wood passes gradually into the narrow bands of summer wood, which is rendered sharply distinct by the line forming its outer edge.

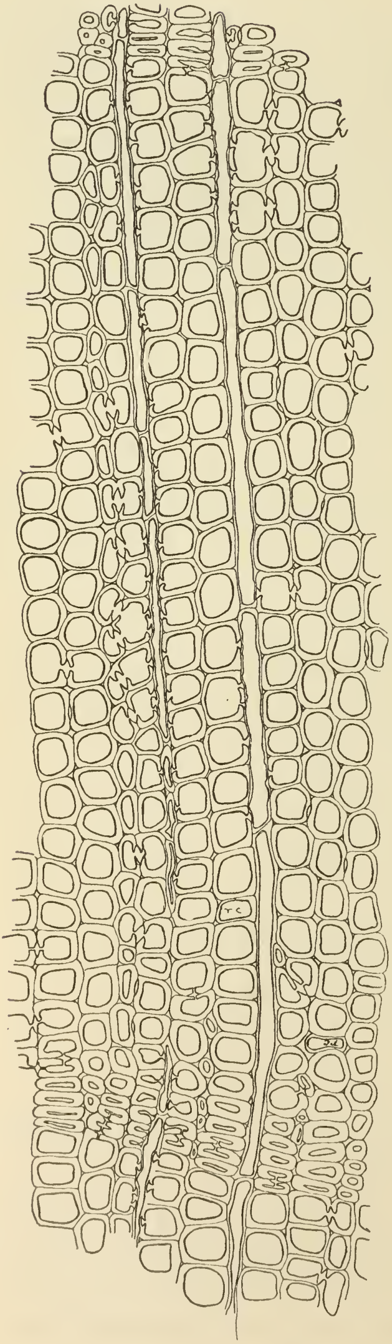

Fig. 2.—Cross section of part of annual ring; *rc*, resin cells—greatly enlarged.

STRUCTURE.

In its elementary structure the wood of Red Cedar presents no essential differences from that of White Cedar. It is free from resinous ducts, which are confined to the primary bark. As in White Cedar, parenchymatous cells filled with resin are scattered throughout the summer wood and early spring wood.

The individual tracheid is quite uniform in its radial diameter; its end is abrupt, usually slightly bent or distorted (fig. 1). In the cross section the cells are quadratic, with the walls of equal thickness; in the later portion of the spring wood they become gradually thickened, and only in the few rows forming the latest part of the summer wood do they become compressed and oblong, with their thickened walls exceeding their lumen (figs. 2 and 3). The pits are bordered where they communicate with the medullary rays (fig. 4, *A*). There are

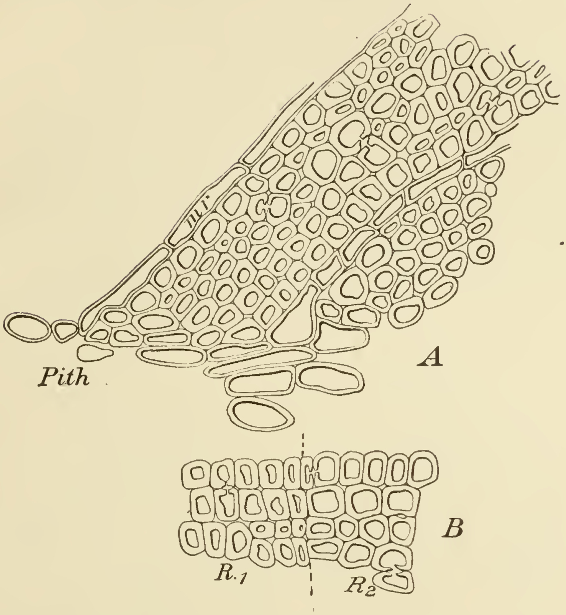

FIG. 3.—Wood cells near center: *A*, part of cross section from near the center; *B*, end of ring 1 and beginning of ring 2—greatly enlarged.

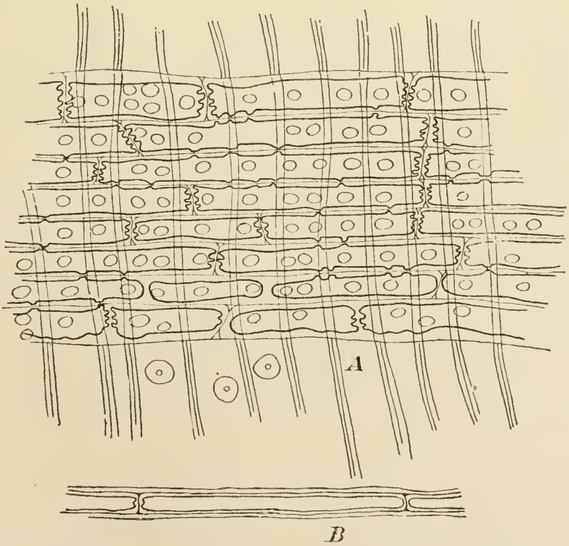

FIG. 4.—Radial section of mature wood: *A*, part of medullary ray; *B*, resin cell—greatly enlarged.

numerous pits on the tangential as well as on the radial wall. The radial diameter of the tracheids is small, averaging 14 mm. in the center of the wood and 19 mm. in its peripheral parts. The medullary rays are simple—that is to say, they are 1 cell wide, as is general in conifers, and from 1 to 12 cells high; rays of from 2 to 6 cells are most frequent (figs. 4 and 5). The rows of cells are uniform, all with the inside wall smooth; their perforations are simple, mostly from 2 to 4 in the larger tracheids of the spring wood adjoining the ray and 1 or 2 to each tracheid of the summer wood. The contents of the medullary rays are frequently resinous. The parenchymatous resin cells, in short rows or single, are scattered in the spring wood or among the tracheids of the summer wood.

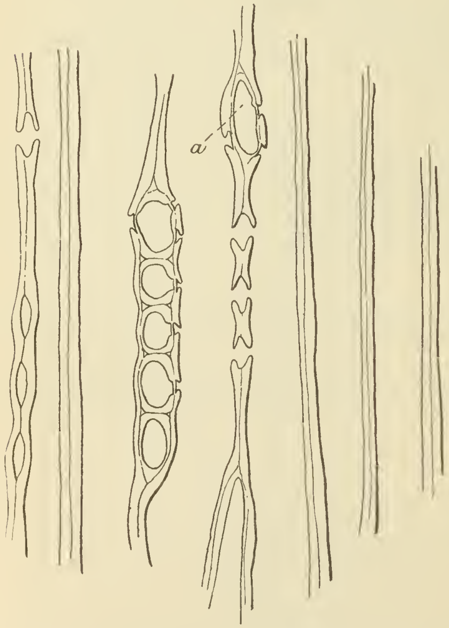

Fig. 5.—Tangential section of mature wood: *a*, a medullary ray of but one cell row. These are quite common—greatly enlarged.

PHYSICAL PROPERTIES.

The physical and mechanical properties of the wood are subject to some variation due to differences in local conditions. The lightest and softest wood is produced on the swampy hummocks of the lower Southern States, notably in Florida. Mr. Roth states: "From what was seen in the woods of Florida, these properties vary within narrow limits, though even here softer and harder wood is distinguished. Apparently some change takes place after the tree has reached full growth, the wood becoming softer with age. It is on this account that the wood of the old shells of rotten logs is considered so well adapted for pencil wood." The same fact has been observed in the hollow logs of fallen timber in northern Alabama. The specific gravity of the wood varies between 0.45 and 0.50, and averages 0.4926. The weight of a cubic foot of air-dried wood is 30.7 pounds.

GROWTH AND DEVELOPMENT.

IN EARLY YOUTH.

The seeds germinate tardily. They may remain for the larger part of the year in the ground without sprouting; in fact, they germinate mostly in the second year.

After unfolding their cotyledons, or seed leaves, the development of the young plants proceeds steadily, and they are soon covered with the sharp primary leaves. At the end of the first year the seedlings are about 4 to 5 inches high. At this early stage of growth the development of the root system proceeds rapidly. At the beginning of the second year the rootlets are of the same length as the plantlet, and the stem produces branches from 1 to 1½ inches long. The slender taproot sends out numerous laterals, which in their turn branch profusely, the fine hair-like rootlets penetrating the fissures of the ground to seek the needed supply of moisture. Thus at this early stage of its development the plant is preparing to gain a firm hold upon the rocky soil to which it is most frequently confined. With the fourth year the seedlings are from 8 to 12 inches high, and the tree enters upon a period of rapid growth. The scale-like foliage leaves make their appearance on the smallest branchlets. During the fifth and sixth years, upon a moderately fresh soil, the tree attains a height of 4 to 5 feet and over, with the stem three-eighths to one-half of an inch thick near the base. Before the end of the fourth season the primary leaves are almost completely replaced by the foliage leaves. On the shallow soil of dry limestone flats and sandy or gravelly hills the primary leaves are retained longer.

In the forests of the Tennessee Valley trees from 10 to 15 years old, scattered among the hardwoods, were found from 7 to nearly 12 feet high, and from three-fourths of an inch to 2 inches in diameter. In the same locality trees from 15 to 20 years old were found to vary greatly in their dimensions, being from 10 to over 18 feet in height and from 1¾ to 2½ inches in diameter. Trees 20 to 30 years old, or a little over, are generally 18 to 24 feet high and 2½ to 3 inches in diameter, the stems clear of limbs 6 to 7 feet above the base. On the sandy dry hummocks in the vicinity of Mobile, stocked with Live Oak, Loblolly Pine, Magnolia, and Yaupon, trees of the age just named average 12 feet in height, branching at the height of 4 to 5 feet above the ground. Two trees which sprung up in the garden of the writer and were transplanted when 4 years old are now 26 years old, and are 25 feet high with a diameter of 11 and 12 inches at breastheight, the soil being a moderately damp, highly sandy loam, with rather compact, retentive subsoil. These trees stand free.

Between the ages of 40 and 65 years the disparity in the size of trees of the same age varies according to differences in soil conditions. A tree growing in the hardwood forest near Russellville, in Franklin County, Ala., on rather shallow soil, showed 55 rings on the stump 18 inches above the ground, and measured 38 feet in height and 12 inches in diameter. In the forests of Franklin County 50 to 60 per cent of the mature trees were affected by decay. They were from 150 to 200 years old, and measured 15 to 22 inches in diameter and 75 to 80 feet in height.

As there is little danger of damage from fire and live stock in the coves of the Tennessee Valley, the prospect is good for the production of a second crop of marketable timber within a comparatively short time. The timber from Butler County varies from 14 to 20 inches in diameter. The logs brought to the mill are generally 24 feet long; those seen at the mill were not considered typical, representing the remnants of a tract in the rugged hills which has been culled over and over for the past dozen years. They were mostly much affected by decay, stunted, and knotty. In consequence, but few measurements were made; these showed that the trees 18 inches in diameter at breastheight were 115 to 125 years old, and those of a diameter of 16 to 22 inches, 130 to 150 years old.

The following diagram (fig. 6), showing graphically the rate of growth of Red Cedar in height at various ages, has been constructed from measurements of 57 trees in Alabama.

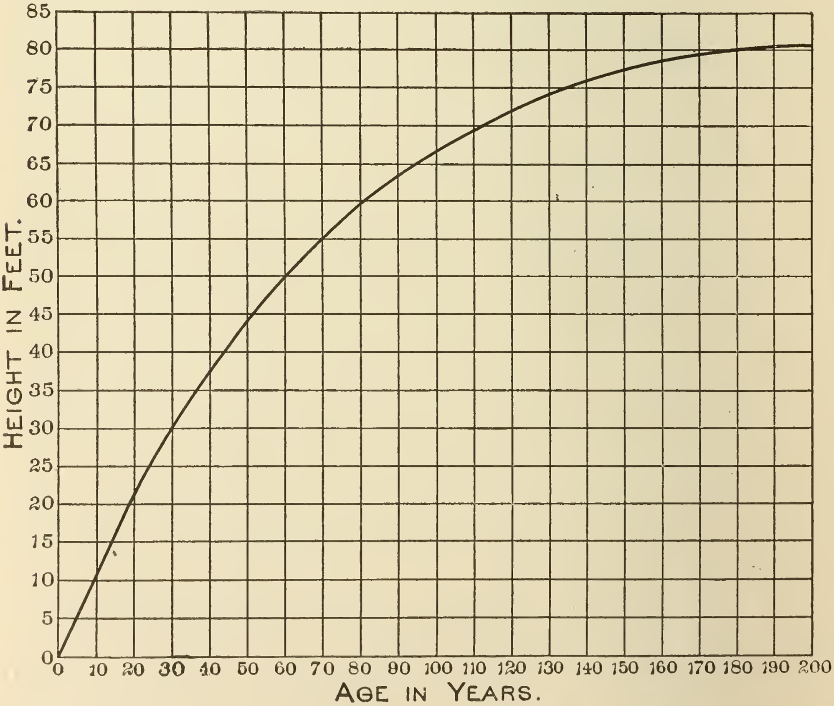

FIG. 6.—Rate of growth of Red Cedar.

IN MIDDLE AGE.

In the rich calcareous soil of a small cove at Cedar Plain, Morgan County, Ala., the rapidity of growth of Red Cedar was most strikingly exhibited by a group of trees which had sprung up in an open spot where they had been left for shade, and the ground around had been frequently plowed for the cultivation of vegetables. All the trees were of uniform size, about 12 inches in diameter and about 25 feet high, with trunks clear for 7 feet. The proprietor stated that these trees were only 12 years old. In the adjoining cedar groves with a dry soil, covered by huge fragments of limestone rock, all the merchantable timber had been cut. Of the few trees remaining, measurements were taken. The following are the results in the case of one tree:

Diameter, breasthigh, 18 inches. Rings on radius of 7¼ inches, 70

	Rings.
For the first inch from center	14
For the second inch from center	8
For the third inch from center	8
For the fourth inch from center	8
For the fifth inch from center	9
For the sixth inch from center	9
For the seventh inch from center	9

Sapwood, 1½ inches, showing 18 rings. Bark, three-eighths of an inch thick. First log, 16 feet long, and 11 inches in diameter at top. Second log, 12 feet long, very knotty throughout. Total height of tree, 56 feet. Timber sound throughout.

Another tree, 14 inches in diameter breasthigh, showed on the stump, 18 inches high, 69 rings. On the radius of 6½ inches were counted:

	Rings.
For the first inch from center	11
For the second inch from center	8
For the third inch from center	9
For the fourth inch from center	6
For the fifth inch from center	8
For the sixth inch from center	17
For the remaining half inch	10

Sapwood, 1½ inches, with about 20 rings. Length of timber (to crown), 24 feet; diameter below crown, 7½ inches. Total height, 60 feet. Timber sound.

Mr. Roth, in discussing the growth and development of Red Cedar in Florida, says:

> In the swamps of the western coast of Florida the Red Cedar is represented by young growth from the seedling up, and the stands are generally dense. For this reason the growth in the young stage is rather slow in diameter, but height growth progresses at from 4 to 18 inches per year. The leaders of young trees (in 1897) from 3 to 10 feet high were generally from 8 to 14 inches long. In the very dense groves of Cedar in the hummocks it would appear that a height of 40 feet and more is attained at the age of about 50 to 60 years. The diameter growth in all fairly favorable situations may be set down at about 0.1 inch a year, so that about five years are required to grow 1 inch in diameter. The native cedar men say that the Cedar grows 1 inch in circumference every year, or 1 inch in diameter every three years, but their view is based on growth of trees several inches thick, and is a little too high.

For the production of timber of the best quality Red Cedar requires from 70 to 120 years, after which the growth declines and decay is apt to set in.

Age and diameter of Red Cedar in western Florida.

(FILIBERT ROTH.)

Age.	Diameter.	Age.	Diameter.
Years.	*Inches.*	*Years.*	*Inches.*
43	7.25	80	10
44	7.75	81	7.5
46	8	82	9.5
50	8	83	7.25
52	7	88	11
52	8.5	90	8.25
52	10	91	6.75
53	8	91	8
53	10	94	9.75
54	6.5	95	11.50
55	14	100	6.50
60	7.5	100	10.5
63	8.5	100	10.75
62	10.5	101	7.5
67	10	106	9
72	10	113	18.5
73	8	113	10
73	12	116	12
73	9	126	12
74	8	125	15
75	10	140	14
80	9.25		

Total height and clear length of Red Cedar in eastern Florida.[1]

(FILIBERT ROTH.)

Total height.	Clear length.	Total height.	Clear length.
Feet.	*Feet.*	*Feet.*	*Feet.*
46	12	59	24
51	27	48	18
48	20	50	----------
42	25	59	12
40	22	38	8
36	24	38	8
48	28	32	14

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[1] Young, thrifty pole timber, which had generally reached the end of active height growth.

ENEMIES.

FIRE.

Fires are highly disastrous to Red Cedar, both on account of the thin bark and the flat root system. In pure cedar forests a fire generally kills practically all the trees. In mixed forest, where the soil is fresher and the fire less fierce, the Cedars are rarely killed outright. They are, however, severely damaged by even a slight charring at the butt, and it is probable that much of the decay characteristic of old Cedar is the result of fire.

LIVE STOCK.

Cattle and goats browse freely on the young plants and tender shoots.

FUNGI.

Of fungoid parasites, several species of Gymnosporangium, such as *G. globosum*, *G. macropus*, and *G. nidusavis* frequently infest Red Cedar. These fungi cause hard globular excrescences on the branches covered with the gelatinous mass inclosing the teleutospores. From these woody swellings, popularly known as "Cedar apples," rise tufts of branches which are called "Witches broom," and which so frequently disfigure the European Fir. The injury caused by Gymnosporangium consists mainly in the death of the branches infested by the fungus.

As has been observed at Greenville, Ala., the wood affected by the decay characteristic of the old trees is covered and permeated by the fine thread of a loose cottony mycelium, which feeds upon the substance, and causes its destruction. The wood attacked in this way becomes a deep chestnut brown. This dry rot is probably of the same nature as the disease which affects the old trees in Florida mentioned by Mr. Roth, and which is spoken of as "brown dote" by the loggers in that section. On the outside of newly felled timber affected by this rot in Butler County, Ala., a white, dry, polyporous fungus of the genus *Poria* was frequently found, forming crusts one-eighth inch thick, scarcely one-half inch wide, and about an inch long, disposed in straight, almost continuous rows. It is probable that this fungus is the fructifying part of the mycelium causing the rot, although the matter awaits further investigation.

Prof. H. von Schrenk[1] recognizes two distinct diseases of Red Cedar caused by the mycelium of polyporous fungi, the white rot and the red rot, or peckiness, of the Red Cedar. Both of these disorders render the timber useless, and both affect the tree in widely separated localities and under various conditions of climate and soil. In many localities fully 60 per cent of the timber is more or less affected by them. All that can be done is to check their spread through the destruction by fire of the fructifying bodies of the fungi wherever they are found.

The white rot (*Polyporus juniperinus* Schrenk) shows itself in the beginning by a slight discoloration of the heartwood toward the center, the woody fiber becoming finally perfectly white by the destruction of its lignin substance, and leaving the cellulose as a fine white film or soft webby threads. With the increase of the mycelium the fiber of the adjoining rings is affected, and in the course of the disease the central mass of the wood becomes completely changed and destroyed. Besides the change of the fiber to cellulose, the threads of the mycelium (hyphæ) attack the bordered pits, causing their destruction and the rapid disintegration of the remaining parts of the tracheid. At the same time the hyphæ destroy also the tissues of the medullary rays, causing narrow cavities radiating in the cross section in all directions from the center of the attack; the wood becomes yellowish brown, brittle, and finally crumbles, by the slightest touch, to a fine powder. The fructifying body shows that this fungus is an undescribed species of Polyporus named by Von Schrenck *P. juniperinus.*

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[1] Bulletin No. 21, Division of Vegetable Physiology and Pathology, U. S. Dept. of Agriculture, Washington, 1900.

In the red rot of the Red Cedar (*Polyporus carneus*) the red color of the heartwood is changed to brown. With the deepening of its color the wood shrinks and cracks. The altered wood is chemically greatly changed. It has the appearance and properties of brown charred wood, is very brittle, and lighter than the sound wood. The cavities appear in the cross section as roundish holes, and the line of demarcation between the sound and affected wood is very sharp. No mycelium is found in the sapwood; the wood between the affected spots is penetrated by hyphæ. In old trees the pockets near the base of the tree become so large, by the uniting of the lesser pockets, that the unaffected sapwood is no longer able to support the tree, and it is frequently broken off by wind.

INSECTS.

Red Cedar suffers more or less severe damage from attacks of insects of various orders. Of Coleoptera, the Juniper Bark-borer (*Phlœosinus dentatus* Say.), is found in living and dead trees. This insect was observed in New England, but whether the death of the tree resulted from its attacks was not ascertained. In Kansas it was found very destructive to Red Cedar. The damage was evidently done by the perfect beetle burrowing under the bark at the base of the lateral shoots of the branches and eating around the base of the twig. Every twig was attacked, and a few insects were observed on the trunks of the trees themselves. This bark borer has been introduced in cedar posts brought to the lumber yards from Michigan and Arkansas. Le Conte states that it inhabits the Middle and Eastern States and Canada. This beetle has so far not been observed in southern Alabama.[1]

The Prussian Blue Pine-Borer (*Callidium antennatum*)[2] has been found with the above in dying and dead trees. Of Lepidoptera, the male and female larvæ of the Juniper Basket-worm (*Thyridopterix ephemeræformis*) feed on Red Cedar. The larvæ may be found at all seasons and in various stages of growth. They are often abundant enough to prove injurious to the tree. Dr. R. Duggar states that the basket-worm has done great damage in Hale County, Ala., particularly to young trees. This insect can be destroyed by picking it off by hand or spraying the tree with an arsenical solution.

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[1] A. S. Packard, Fifth Report U. S. Entomological Commission, Washington, D. C., 1890.

[2] A. S. Packard.

The Juniper Twig Inch-Worm, the larva of a small moth (*Drepanodes varus*), also feeds on the leaves of the tree. This caterpillar is a rough-bodied span or measuring worm, about 1½ inches long, and bears a close resemblance to the smaller twigs of the tree; it changes to an ocher-brown moth. It is not rare in New England, and has also been observed in northern Alabama.

A firm engaged in the manufacture of pencil wood mentions that little holes of the size of a pin, caused by pinworms, are sometimes found in Red Cedar, and further speaks of the "borer," a small caterpillar with two small, finger-like cutters projecting from its head, as the greatest source of destruction of pencil cedar. This worm is said to eat or to bore its way through the log, leaving the hole it makes filled with fine sawdust. Large logs that would otherwise be of great value are frequently honeycombed and a mass of sawdust. This is from all appearances the work of some Longicorn beetle. A similar state of affairs in the timber of the Red Cedar has been observed among the logs at the cedar pencil mill at Gurley, Ala., and recently at the pencil wood manufactory near Greenville, Ala., made by the grubs of Capricorn beetles, larger than those described above. F. Roth states that the tree suffers frequently in Florida from the attacks of boring insects, followed by the white ant, which completely riddles the logs, and that it is owing especially to these insect ravages that there is so much waste in the manufacture of Red Cedar. The large hollows so frequently found in the trunks of the old trees planted near houses on the coast of Alabama and Mississippi, are inhabited by colonies of the large black wood ants. It can not be stated, however, whether they injure the tree.

NATURAL REPRODUCTION.

Red Cedar reproduces freely throughout its natural habitat, and most abundantly on limestone soil in the Southern States. The birds feeding upon its fruit assist in no small measure to scatter the seed. The young growth has a decided advantage over that of most of the trees with which it is associated on account of its tolerance of, or power to endure, shade. It is found spreading over abandoned grounds in New England and over the limestone hills and flats in the South, and holds its own on the cedar hummocks of the prairie region and of the Gulf shore. As a rule, it predominates largely among the young growth wherever Red Cedar originally abounded. An exception to this rule is found only on steep slopes, where the seeds are apt to be carried away by heavy rains before they have had time to germinate.

FOREST MANAGEMENT.

The following notes on the form of forest management advisable for Red Cedar are of a preliminary nature only. A good deal more study on the ground is necessary before it will be possible to decide how the conservative lumbering of red cedar forests had best be carried on. This investigation will be undertaken in its turn by the Division of Forestry.

The present scarcity of marketable Red Cedar, coupled with the great importance of a steady and adequate supply, makes systematic forest management imperative. The high quality of the wood in the Southeast, its comparatively rapid growth, and the ease with which reproduction can be obtained, indicate this region as the one best suited to the growth of Red Cedar and to the application of forestry with a prospect of successful management.

The fact that Red Cedar bears seed every year and that the seedlings are decidedly tolerant of shade renders its reproduction by no means a difficult matter. This is true in all localities favorable to the growth of the tree, as on the cedar hummocks of the prairie belt in Alabama, in the forests on the hills of the Tennessee Valley, and in the cedar hummocks of western Florida. It is evident that, under proper management, Red Cedar might be made to yield a steady supply of valuable timber. This would require the protection of the forest from fire and live stock and slight modifications of lumbering methods, so as to avoid unnecessary damage to the forest. It is probable, also, on account of the high merchantable value of Cedar even of small diameter, that a more intensive system of management could be applied to cedar forests than is generally advisable in this country. Thinnings, generally impossible on account of their expense, would in the case of the Cedar be likely to yield a fair revenue in addition to their good results from a silvicultural point of view.

Upon barren flats and dry limestone hills, where scarcely any other tree besides the Cedar can succeed, the dense undergrowth should be carefully preserved in the removal of the merchantable timber, and a sufficient number of seed-trees should be left standing. Denuded of their forest growth, these cedar barrens become absolutely unproductive, and to restock them with Cedar would be exceedingly difficult, if not practically impossible. On the other hand, by the exercise of a reasonable amount of care in logging they can be made to produce a steady supply of pole timber. More detailed directions along this line must await the results of further investigation.

The attempt made by L. von Faber to establish a forest of pure Cedar in central Germany has so far met with encouraging success. The three-year-old seedlings from the nursery were planted about the middle of the seventies. The plantlets, scarcely 1½ feet high, survived the extraordinarily severe winters of 1879–80 and 1880–81, which caused great damage to trees and plants. In the year 1896 the trees showed a clear length of 12 feet, and the plantation was thrifty and promising.

RED CEDAR PLANTATIONS.

Red Cedar plantations are best established by using seedlings from the nursery. To hasten germination the berries should be soaked for some time in hot water as soon as they are ripe, and then mixed with sand and kept moist until the following year. They may be planted either in the fall, a year from the time they were gathered, or in the following spring. Treated in this way the seeds will sprout in a few weeks after sowing. The seedlings should be transplanted in the spring of the second season, about 5 inches apart. By the end of their second year the plants will be 7 to 8 inches high and well rooted. It is best to transplant again at the opening of the third season, setting them out in March or April, about 8 or 9 inches apart. When finally transplanted in the following spring the plants should be taken up with a ball of earth and planted at a distance of 4 feet apart, and well watered after planting. They will soon shade the ground, and need no further care. When they reach the pole stage, and before the period of most active growth has been passed, thinning will become necessary from time to time for the sake of an increased rate of diameter growth. The young poles and saplings furnish material for fencing, stakes, and hoops, yielding an income which will go far toward covering the expenses of the management of the plantation. At a diameter of 6 inches the tree furnishes excellent posts.

The formation of the heartwood begins early, and trees scarcely 10 inches in diameter and but little over fifty years old will furnish pencil wood.

NOMENCLATURE AND CLASSIFICATION.

The name under which the Red Cedar was described by Linnæus, *Juniperus virginiana*, has received from the first general recognition in systematic botany, and will stand unaltered. The common name of the tree, which is derived from the color of its wood, is not appropriate, as it can not be classed with the cedars. Savin, the name by which it goes in many localities, if *American* were added, would be strictly correct, the tree belonging to the natural section or subgenus Sabina (savin) of the genus Juniperus. The true savin differs from Junipers proper by the presence of primordial leaves in the early stage of its growth and by the concrescent, scale-like leaves of the older trees.

BOTANICAL DESCRIPTION AND MORPHOLOGY.

Evergreen trees from medium to moderately large size with somewhat obscurely angled to flat branchlets. Leaves dimorphous, those of the older tree decussate, scale-like, with entire margins, acute; in the earliest stages of growth and on the youngest shoots of older trees

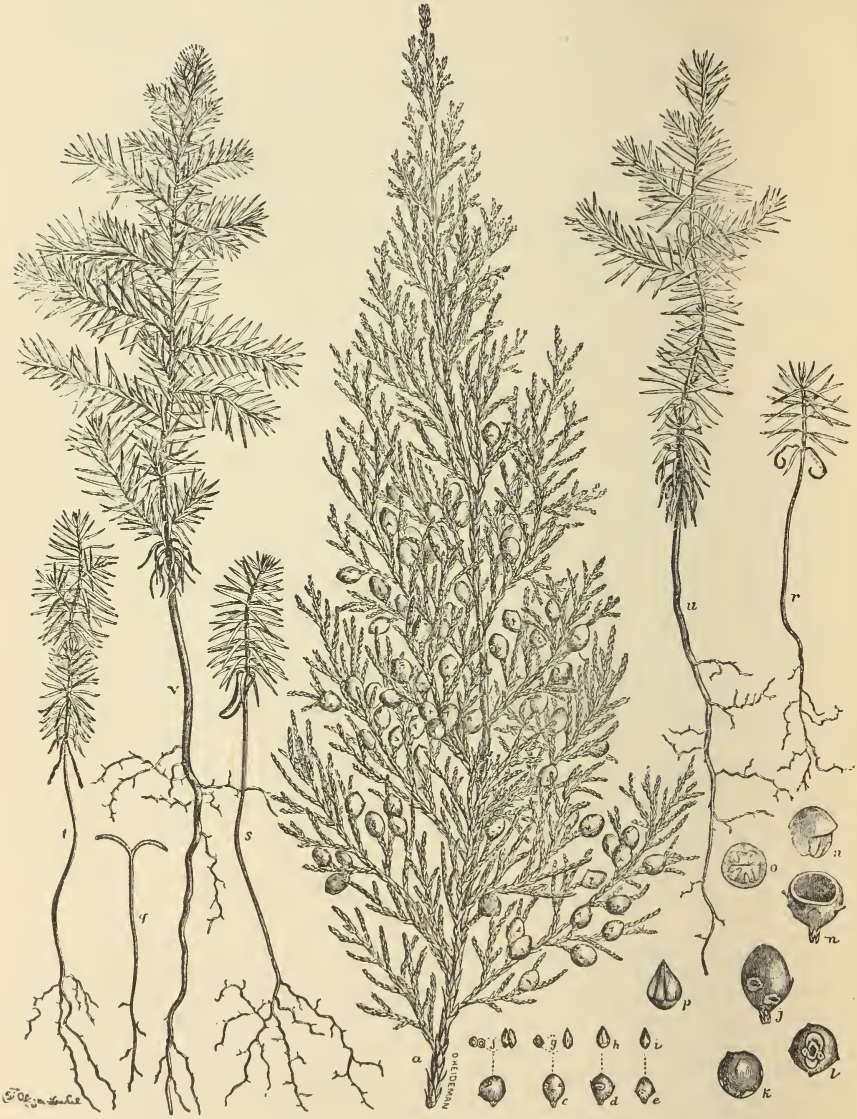

FIG. 7.—Red Cedar seeds, plantlets, etc.: *a*, fruit-bearing branch—natural size (November); *b*, *c*, *d*, *e*, strobiles in different stages of development; *f*, *g*, *h*, *i*, strobiles with their seeds; *k*, mature fruit (galbulus), seen from above; *l*, mature fruit, from below; *j*, mature fruit, from the side; *m*, mature fruit, with seeds removed; *n*, galbulus, pulp removed about the base; *o*, cross section, through base of fruit; *p*, seeds—enlarged; *q*, seedling with cotyledons just unfolded—natural size (February); *r*, plantlets several weeks old; *s*, same, little over a month old, primary axis yet undivided; *t*, primary stem producing secondary axis; *u*, seedling 5 to 6 months old; *v*, same at the end of the first year. Plantlets all covered with the acerose primary leaves, natural size. (Drawn from specimens collected in the District of Columbia.)

in whorls of three, rigid, needle-shaped, acute. The fruit, a small, short-stalked, fleshy conelet, is globular, berry-like, of a dark purple color, with a whitish bloom, and incloses one or two angular grooved seeds.

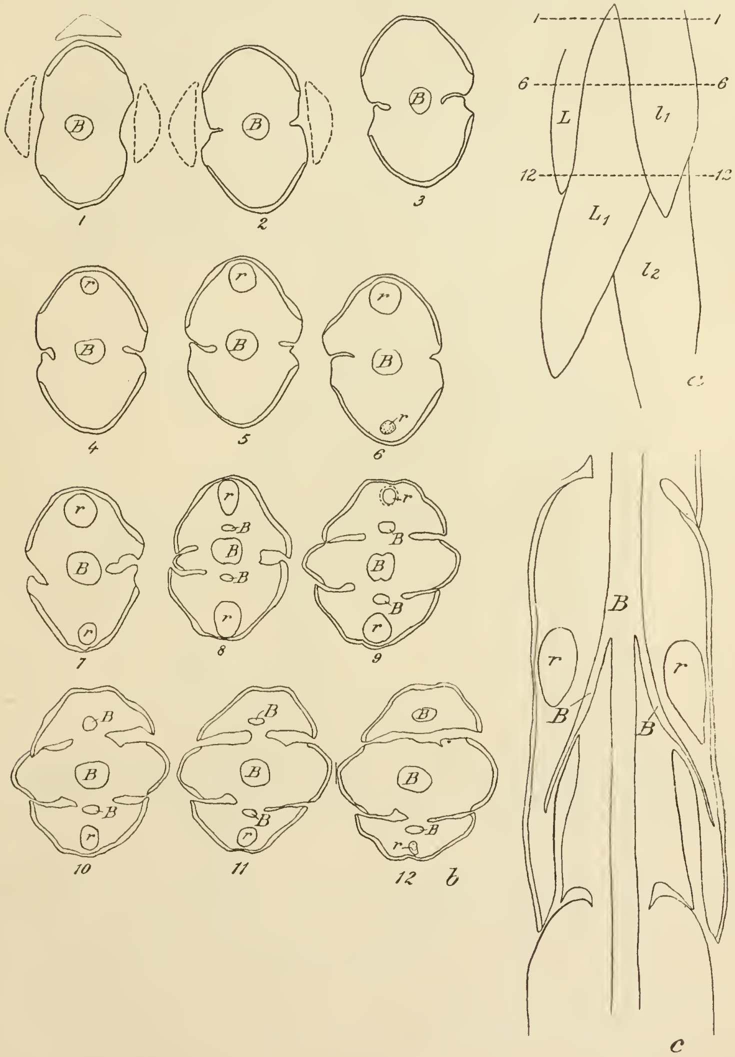

FIG. 8.—Leaves of Red Cedar:
a, arrangement of leaves on twig, dotted lines showing position of cross sections.
b, series of cross sections: *B*, fibro-vascular bundles; *r*, resin pockets.
c, longitudinal section: *B*, referring to fibro-vascular bundles; *r*, to resin pockets as in *b*—enlarged.

ROOT, STEM, AND BRANCH SYSTEM.

The root system of the Red Cedar is flat, and the taproot is at the earliest stages far exceeded in length by numerous densely branched lateral roots.

The full-grown tree varies greatly in shape and size; as generally met with in the cedar glades, it reaches a height of 50 to 75 feet, free from limbs for half of its length, and from 12 to (rarely) 20 inches in diameter at breastheight. The trunk is often fluted at the base. On the dry limestone flats of the barrens and on poor sandy hills the tapering trunk is covered with branches from the base, and is full of knots and dead limbs. It attains its best growth associated with hardwood trees, in the fertile valleys and on the rich benches and in the coves and on the hillsides, with a deep, fresh soil; here it reaches a height of from 75 to 100 feet, clear of limbs for 50 to 60 feet, and is from 1½ to 2½, rarely 3, feet in diameter. On the sandy or rocky beach, exposed to the storms of the sea, the trunk is short and crooked.

The bark is at first close, about one-eighth inch thick, and of a light gray color on the outside; the inner bark is reddish, and soon becomes shreddy. In habit of branching, the tree presents a variety of forms. Under ordinary conditions and free exposure, the limbs are stout and more or less horizontally spreading, the crown resembling that of the Shortleaf Pine in outline. On the limestone flats, the branches soon become erect, giving rise to a pyramidal crown, and in the dense mixed forest the head assumes the spiry form characteristic of most coniferous trees. These variations can not always be ascribed to differences in soil and exposure; trees growing side by side often show great differences of form.

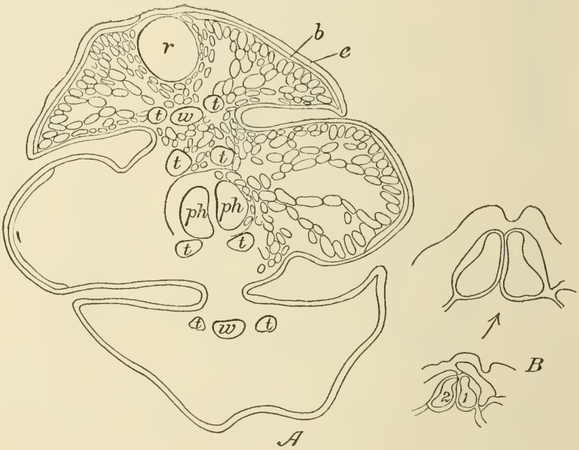

Fig. 9.—*A*, section through shoot passing near base of one pair of leaves and near where the other pair becomes free, same as in Fig. 8 *b*, 11, 12: *r*, resin duct; *w*, wood; *ph*, phloem or inner bast; *t*, tracheids or cells with dotted pits; *e*, epidermis; *b*, sclerenchymatous or bast layer. *B*, stomata near end of leaf—greatly enlarged.

LEAVES.

The cotyledons are two in number, linear, obtuse (fig. 7, *q*). The primordial leaves soon cover the rapidly developing primary axis and its ramifications in whorls of three, rarely in pairs; they are about three-eighths of an inch long and one-sixteenth wide, rigid, sharp-pointed, channeled above, with a strong midrib. The stomata (breathing pores) are somewhat irregularly placed in 4 to 5 rows in the direction of the fibro-vascular bundles. These primordial leaves resemble closely the leaves of the section Oxycedrus of the genus. They persist during several seasons, are produced in the seedlings up to the fifth and sixth year, and make their appearance on the vigorous shoots of old trees, growing from adventitious buds and from their youngest branchlets (fig. 7, *r*, *s*, *t*, *u*, *v*).

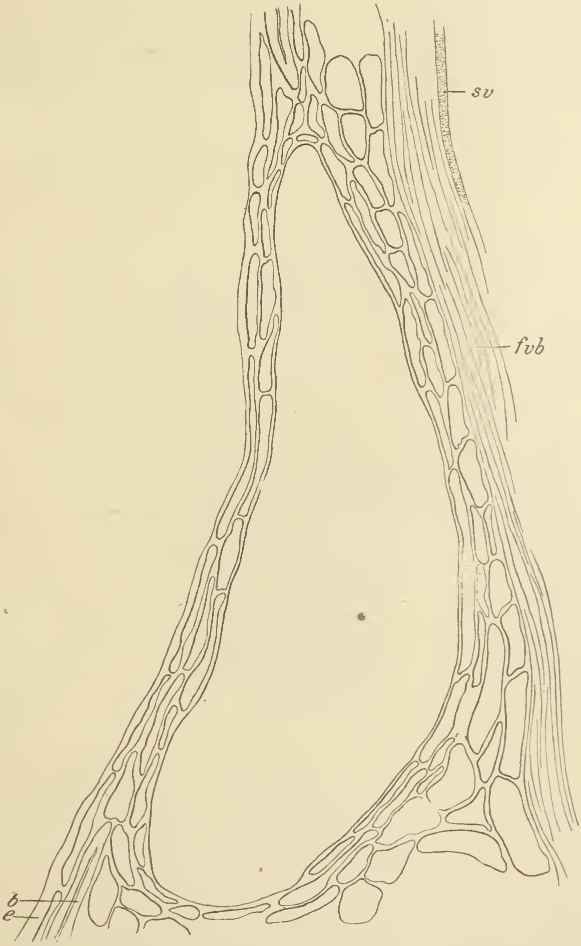

FIG 10.—Longitudinal section of resin duct: *e*, epidermis; *b*. bast or sclerenchyme fibers; *sv*, scalariform vessels; *fvb*, fibrovascular bundles—greatly enlarged.

The secondary leaves (foliage leaves) constitute the mass of the foliage of the tree after it has passed the earlier stages of its growth.

In arrangement and structure they are similar to the leaves of White Cedar (fig. 7, *a*, fig. 8, *a*, *b*, and fig. 13, *a*). The leaves of Red Cedar, however, are narrower, more attenuated toward the free apical part, and with the margin entire. The dorsal and ventral rows show no difference in the form of their leaves, and the branchlets present an obscurely angled outline.

Mr. Filibert Roth says:

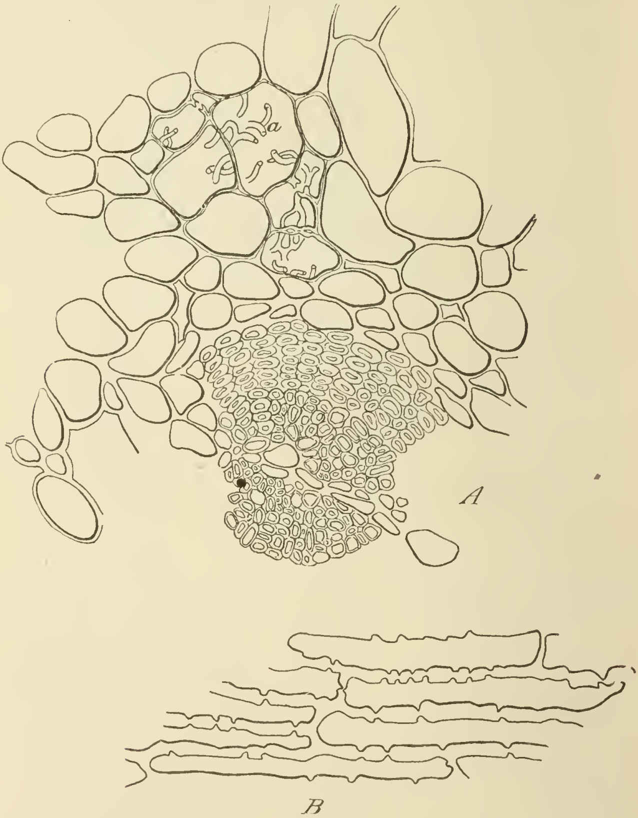

FIG. 11.—*A*, cross sections of fibrovascular bundle and its surroundings: *a*, peculiar curved projections from the walls of the tracheid cells; *B*, inner aspect of epidermis—greatly enlarged.

> The epidermis consists of a layer of flattened elongated cells (fig. 10, *e*), with rather thick walls, communicating by simple pits (fig. 11, *B*), and on the inner side of the free part of the leaves the epidermis is covered by numerous stomata. On the dorsal side of the leaf the epidermis is underlaid by a simple layer of strengthening (sclerenchymatous) cells, which are doubled in the corners and also on both sides of the glands, over which the hypodermal layer does not extend. (See figs. 10, *b*, *c*, and 12, *A*, *B*.) On each side of the fibro-vascular bundle is placed a group of tracheid-like elongated cells with lignified walls and bordered pits, as is also seen on each side above and below the vascular bundle of the common leaf axis. These tracheid-like cells show the more or less peculiar curved projections from their walls, a feature characteristic of the dorso-ventral-leaved section of

Juniperus (fig. 11, *A*). The fibro-vascular bundle passes along the ventral side of the gland and contains on its border scalariform cells (fig. 10). The parenchymatous tissue is loose, composed of large cells, the palisades normal to the surface.

FLOWERS.

The flowers are generally diœcious; it is very rare that pistillate and staminate flowers are found upon the same tree. The staminate (male) flowers are sessile on the ends and sides of the ultimate branchlets, without involucre (fig. 13, *b*, *d*), the staminodial column rising from the center of the last pair of the unchanged leaves (fig. 13, *i*). They are of a yellowish buff color, scarcely one-eighth inch long, and are produced in great profusion. The floral axis produces 10 to 12 stamens in decussate pairs, the anthers with their convex, shield-like crest bearing from 3 to 4 pollen sacs at the base (fig. 13, *i*, *k*, *l*, *m*, *n*). The pollen is discharged by an irregular slit (fig. 13, *l*). The roundish pollen grains are somewhat irregular in shape, and roughish on the surface.

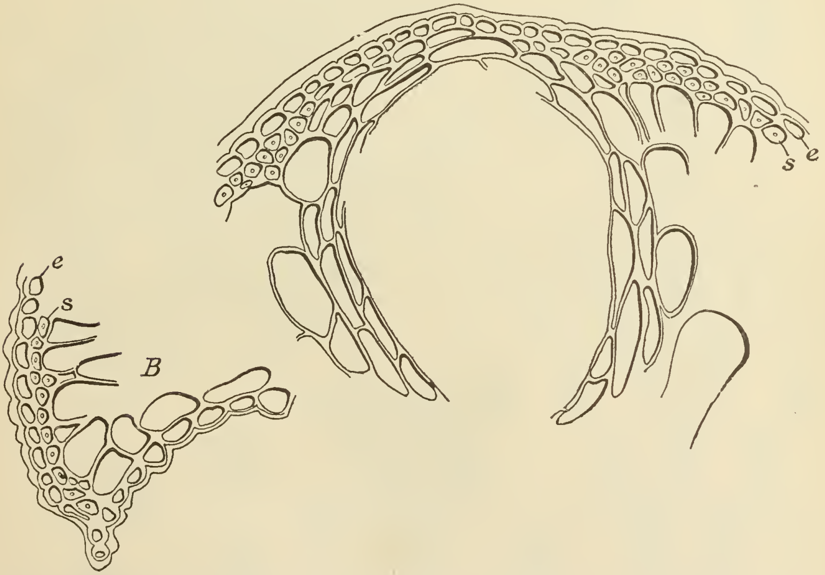

FIG. 12.—Leaf structure: *A*, section through resin duct; *B*, section through "corner," or lateral edge of leaf: *e*, epidermis; *s*, sclerenchyme or bast cells—greatly enlarged.

The pistillate flowers are very numerous; they are collected in a small sessile ament, destitute of involucral bracts, and their disposition on the ultimate branchlets is similar to that of the staminate flowers (fig. 13, *a*, *c*). The inflorescence consists of two pairs of carpellary leaves placed crosswise (fig. 13, *e*, *f*, *h*). Those of the first or lower pair are broadly ovate, acuminate, and sterile; and of the upper pair, thickish with involute edges, pointed, of a pale, almost whitish color, bearing at their base the oblong, ovate, flask-shaped ovule with the opening of the neck two-lipped. In the large number of aments

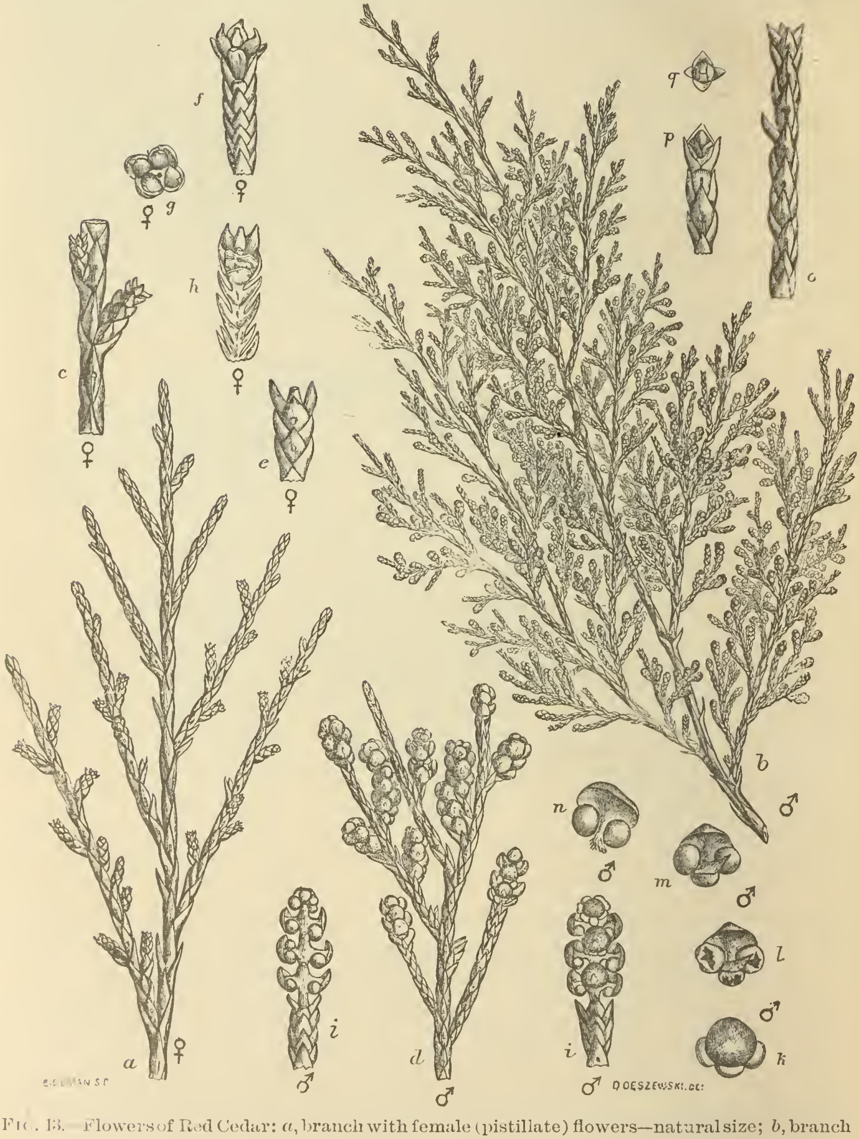

FIG. 13. Flowers of Red Cedar: *a*, branch with female (pistillate) flowers—natural size; *b*, branch with male (staminate) flowers—natural size; *c*, pistillate branchlets—slightly magnified; *d*, staminate branchlet—slightly magnified; *e*, detached ament; *f*, ament bearing branchlet, anterior leaf of ultimate whorl bent down to show female inflorescence—enlarged; *g*, cross section of ament: *h*, longitudinal section of ament bearing branchlet, showing the pair of sterile thickened capillary leaves and one ovule—enlarged; *i*, staminate flower detached, fully open, longitudinal section of staminodial column; *k*, anther with 3 pollen sacs not yet open, seen from above; *l*, anther, ventral side, detached, pollen sacs ruptured on discharge of pollen; *m*, the pollen sacs, closed; *n*, side view of anther, with pollen sacs to the right and the left of the filament—enlarged; *o*, staminate branchlet, after pollen has been shed; *p*, ultimate male branchlet, after flower has been shed; *q*, ultimate whorl, seen from above. (Drawn from specimens collected in the District of Columbia.)

examined more than two ovules were never found, and frequently only one.

The flowers open about the beginning of March.

FRUIT.

After fecundation, the carpellary scales soon coalesce and with their increase in size soon become fleshy, the conelets assuming the form of a pulpy berry (fig. 7, *a* to *e*, *j*, *k*). This berry-like cone (galbulus) is supported by a short, erect stalk, and matures uniformly late in the fall of the first year, frequently remaining on the tree until late in the following spring. No tree has been observed to bear green and ripe fruit at the same time. The so-called berries when fully ripe are globular, about one-eighth of an inch thick, purplish black, roughish, with a whitish bloom, soft, and pulpy. The pulp incloses several vesicles filled with an oleo-resin attached to the seeds near the base, and from 1 to 2 seeds; the seeds are hard, with a thick, bony covering, ovate-oblong, and acute, with 2 or 3 prominent ridges (fig. 7, *p*) extending from near the base to the roughish apex.

The fruit of the Red Cedar is the favorite food of many birds, particularly the Carolina Waxwing, or Cedarbird (*Ampelis cedromus*), which serve as active agents in spreading the species. The tree begins to bear fruit when between 15 and 20 years old. It appears that full crops can not be depended upon every year, and that generally one or two years may elapse before another seed year occurs.

BARBADOS RED CEDAR.

(*Juniperus barbadensis* L.)

The identity of the Barbados Red Cedar as it occurs in the United States has only recently been recognized. Heretofore this cedar has been considered a southern form of the northern species. The Barbados Red Cedar occurs within a narrow subtropical coastal region extending from Georgia to Florida, and westward along the Gulf shore to eastern Texas. It occurs, also, in the mountains of Jamaica and other West Indian islands.

The specific characters of this tree differ only slightly from those of its northern ally (*Juniperus virginiana*). These distinctions consist chiefly in the minute, closely imbricated, mostly blunt, or rarely acute, leaves, which are provided with a more or less oblong, or linear, oil gland. The staminate flowers of the Barbados Red Cedar are longer than those of the northern species, and the globose, bluish-black fruit is smaller. The tree is further distinguished by its more widely spreading branches and drooping branchlets, the roundish, oval crown of the tree being rather open.

The structure and physical properties of the wood are practically alike in both species.

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